Appendix H
System Impact Study

STERLING ENERGY SYSTEMS, INC
SOLAR ONE PROJECT

SYSTEM IMPACT STUDY

March 7, 2006

SOUTHERN CALIFORNIA
EDISON
An *EDISON INTERNATIONAL*[SM] Company

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EXECUTIVE SUMMARY

Sterling Energy System, Inc (SES) applied to Southern California Edison (SCE) for Interconnection of a new 850 MW solar generation project (SES Solar One) pursuant to Section 5.7 of the CAISO Tariff. The proposed generation project consists of numerous sterling dish systems and is to be located approximately two miles north of the SCE Pisgah 230 kV Substation. SES proposes to construct new generation tie line facilities, which will connect the SES Solar One Project to the SCE Pisgah 230 kV substation. The evaluations included study conditions with all generation projects in queue ahead of the SES Solar One Project.

SCE performed a System Impact Study, as requested, to determine the adequacy of SCE's transmission system to accommodate all or part of the proposed project. This study identifies the extent of any congestion and determines if there are any negative impacts to reliability. New special protection systems (SPS), facilities, or system upgrades will be recommended to maintain system reliability in accordance with SCE's Reliability Criteria for non-CAISO controlled facilities and in accordance with CAISO Reliability Criteria for CAISO controlled facilities. The results of the System Impact Study will be used to determine project cost allocation for facility upgrades. **The study accuracy and the results for the assessment of system adequacy are contingent on the accuracy of the technical data provided by the customer as shown in Figure 1-1 through Figure 1-4 and Appendices C and E.** Any changes to the attached data could invalidate the study results and may require reassessment.

POWER FACTOR CORRECTION

Based on load flow study results, SCE will require the SES Solar One Project to be able to provide reactive support corresponding to a 0.95 power factor boost.

LOAD FLOW RESULTS

The north of Lugo transmission corridor does not have sufficient capacity to accommodate the SES Solar One Project without facility upgrades. In addition, the SES Solar One Project was found to increase South of Lugo transmission flows. Adding more generation north of Lugo or increasing imports from the north will further impact south of Lugo line flows. This study identified that approximately 50 MW of the project's 850 MW flows South of Lugo under generation redispatch patterns that minimize increases to South of Lugo. Different redispatch flow patterns will result in higher increases to the south of Lugo flows. Furthermore, generation located north of the SCE Lugo Substation is part of the Southern California Import Transfer (SCIT). Consequently, the SES Solar One Project may be subjected to system limitations not identified in this report and be subject to dispatch with all other imports for transmission capacity according to the SCIT Nomogram.

The power flow studies identified that base case overloads, with all facilities in service, triggered by projects in queue ahead of the SES Solar One Project were not significantly aggravated by the SES Solar One Project. However, the study identified that the SES Solar One Project triggers new base case overload problems on the two existing Lugo-Pisgah 230 kV transmission lines and two Lugo 500/230-kV transformer banks. In addition to the base case overloads, the studies identified numerous single contingencies that result in severe thermal overload problems some which are aggravated by the SES Solar One Project. It's worth noting that the two Lugo-Pisgah 230 kV transmission lines do not have any emergency capability due to line clearance. As a result, the use of a Special Protection System to mitigate thermal overloads on these two transmission lines is not recommended since a large number of facilities, beyond SCE's design limitation, would need to be monitored and implemented into the special protection system logic processor. Facilities upgrades will therefore be needed to mitigate these overload problems.

With upgrades modeled into the base case, the study identified that all impacts associated with the inclusion of the SES Solar One Project were mitigated except for loss of two 500 kV lines South of Lugo. Under such outage conditions, the South of Lugo flows were found to exceed the maximum south of Lugo capability.

BASE CASE CONGESTION MANAGEMENT

For reasons discussed above, SCE does not recommend implementation of congestion management protocols as a mitigation option to manage flows on the two existing Lugo-Pisgah 230 kV transmission lines. Since the SES Solar One Project is being phased in over four to five years beginning in 2009 and SCE has identified a transmission project (Vincent to Mira Loma 500 kV transmission line) which will increase the total deliveries from the north into Mira Loma, SCE recommends the use of congestion management to limit south of Lugo flows to within limits (5600 MW post Mira Loma Loop). If for some reason, the Vincent to Mira Loma 500 kV transmission line project is terminated, additional congestion management not identified in this study may be needed.

TRANSIENT STABILITY RESULTS

A number of transient stability problems were identified with the addition of the SES Solar One Project. The most critical problem includes the identification of no low-voltage ride-through (LVRT) capability with use of the generation model provided in Table 1-4 in the assumptions section. This problem impinges on the operator's ability to properly operate the transmission system. The study identified generation disruptions on numerous faults located throughout the Western United States. Sensitivity studies performed with larger inertia constants in order to maintain generators connected identified WECC voltage criteria violations and system instability problems. Engineers at SES have been evaluating the potential LVRT issue with assistance from GE Power Systems Consulting Division. SES has informed SCE that it is in the process of developing a more detailed dynamic model that better reflects the dynamic performance of the Solar Dish Systems. SES will be required to provide SCE with the updated dynamic model upon completion in order to re-examine transient stability system performance prior to finalizing Facilities Study.

SHORT-CIRCUIT DUTY RESULTS

Studies assuming the Solar Dish Systems remained connected identified eleven substation locations where the duty was increased by more than 0.1 kA and duty exceeded 60% of the minimum breaker nameplate rating, without facility upgrades modeled. The number of substation locations where the duty was increased by more than 0.1 kA and duty exceeded 60% of the minimum breaker nameplate rating increased to twenty-two and twenty-three with the initial set of upgrades and final set of upgrades modeled respectively. SCE recommends that the more detailed dynamic model representation under development by SES also include a more detailed short-circuit duty model which would better reflect short-circuit duty contributions from the project. As part of the Facilities Study, SCE will evaluate the substation locations identified in this study to determine need for upgrade or breaker replacement. A restudy for short-circuit duty and reevaluation of any identified substation locations will be needed once the new model is made available.

SPECIAL PROTECTION SYSTEM REQUIREMENT

With the initial set of facility upgrades modeled, a special protection system will be required to trip the project under two different outage conditions. Tripping is not recommended for loss of two south of Lugo 500 kV transmission facilities as loading on these facilities should be managed under base case conditions, as recommended above. With the final upgrades modeled, the need for a special protection system is reduced to one outage condition. The outages requiring need for a special protection system are summarized below.

Transmission Facility Outage	Initial Upgrades	Final Upgrades
Lugo-Pisgah 500 kV Transmission Line (N-1)	SPS	No SPS
Pisgah 500/230 kV Transformer Bank (T-1)	SPS	No SPS
Lugo-Pisgah 500-kV Transmission Lines (N-2)	Doesn't Exist	SPS

OPERATIONAL STUDY REQUIREMENTS

The SES Solar One Project has indicated a desire to interconnect and expand their project over a period of five years. Initially, they would like to interconnect prior to the in-service date of the final facility upgrades. As a result, an Operational Study will be necessary to examine the need for facility upgrades to interconnect the SES Solar One Project and those projects with an in-service date up to the same year as the SES Solar One Project. Any facility upgrades identified to be needed under this interconnection ordering sequence will be required prior to allowing interconnection of the SES Solar One Project. Additional facilities, not identified in this study, may be necessary to allow for such initial interconnection. Schedule and cost of such facilities, to be identified in an Operational Study if requested by SES, is not identified in this System Impact Study report. This information will be provided as part of the Operational Study, if requested.

FACILITY STUDY

A Facility Study will be required to determine the facilities and upgrades necessary to interconnect the proposed SES Solar One Project. The study should:

1. Perform additional transient stability studies with an updated dynamic model to be provided by SES. It is anticipated that SES will provide such model to SCE within four to six weeks from publishing of this report. SCE will provide transient study results with the updated model to the CAISO upon completion.

2. Investigate feasibility and develop cost associated with removing one existing Lugo-Pisgah 230 kV transmission line and replacing with a new Lugo-Pisgah 500 kV transmission line. The remaining Lugo-Pisgah 230 kV transmission line is to be idled (left in place for future use).

3. Investigate feasibility and develop cost associated with looping the existing Lugo-El Dorado 500 kV transmission line in and out of a new Pisgah 500 kV substation.

4. Develop cost associated with expanding and converting the existing Pisgah 230 kV substation to a 500 kV substation. The substation design should include:

   - a new 500 kV switchrack
   - two 500/230 kV transformer banks
   - three 500 kV transmission line positions with a design to allow for a fourth line
   - equipping positions 3 and 6 with breakers to allow for transformer bank connections
   - expansion of 230 kV switchrack to allow termination of new SES Solar One Gen-Tie

5. Review circuit breakers at the twenty-three locations identified to determine need for breaker replacement and develop cost estimates. A restudy for short-circuit and reevaluation will be needed once the new model is made available. SCE will provide revised short-circuit duty results with the updated model to the CAISO upon completion.

6. Develop and provide cost for appropriate special protection system.

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I. INTRODUCTION

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SCE performed a System Impact Study, as requested, to determine the adequacy of SCE's transmission system to accommodate all or part of the proposed project. This study identifies the extent of any congestion and determines if there are any negative impacts to reliability. New special protection systems (SPS), facilities, or system upgrades will be recommended to maintain system reliability in accordance with SCE's Reliability Criteria for non-CAISO controlled facilities and in accordance with CAISO Reliability Criteria for CAISO controlled facilities.

The results of the System Impact Study will be used to determine project cost allocation for facility upgrades. **The study accuracy and the results for the assessment of system adequacy are contingent on the accuracy of the technical data provided by the customer as shown in Figure 1-1 through Figure 1-4 and Appendices C and E.** Any changes to the attached data could invalidate the study results and may require reassessment.

The study includes power flow (steady-state and post-transient), transient stability, and short-circuit duty analysis as well as order of magnitude cost estimates and schedule timelines. The study was performed for two system conditions: (a) 2009 heavy summer load forecast (once-in-ten-year heat wave assumption) with very high generation in the system north of Lugo including high imports from the East and (b) 2009 light spring load forecast (65% of 2009 heavy summer) with very high generation in the system north of Lugo including high imports from the East.

II. STUDY CONDITIONS AND ASSUMPTIONS

A. Planning Criteria

The system impact study was conducted by applying the Southern California Edison and California Independent System Operator (CAISO) Reliability Criteria. More specifically, the main criteria applicable to this study are as follows:

Power Flow Assessment

The following contingencies are considered for transmission and subtransmission lines, 500/230 kV transformer banks ("AA-Banks"), and 230/115 kV transformer banks ("A-Banks"):

- Single Contingencies (loss of one line **or** one AA-Bank)
- Double Contingencies (loss of two lines **or** one line and one AA-Bank)
- Outage of two Lugo AA-Banks is beyond the Planning Criteria but is currently mitigated as part of an existing "Safety Net" protection scheme due to potential cascading impacts

The following loading criteria are used:

Transmission Lines	Base Case	Limiting Component Normal Rating
	N-1	Limiting Component A-Rating
	N-2	Limiting Component B-Rating
230/115 kV Transformer Banks	Base Case	Normal Loading Limit
	Long-Term & Short-Term	As defined by SCE Operating Bulletin No.33
500/230 kV Transformer Banks	Base Case	Normal Loading Limit
	Long-Term & Short-Term	As defined by SCE Operating Bulletin No.33

The following principles were used in determining whether congestion management, special protection systems, or facility upgrades are required to mitigate base case, single contingency, or double contingency overloads:

- Congestion management, as a means to mitigate base case overloads, can be used if it is determined to be manageable and the CAISO concurs with the implementation

- Facility upgrades will be required if it is determined that the use of congestion management is unmanageable as defined in the congestion management section

- Special protection systems (SPS), in lieu of facility upgrades, will be recommended if the system is simple and effective, does not jeopardize system integrity, does not exceed the current CAISO single and double contingency tripping limitations, does not adversely affect existing or proposed special protection systems in the area, and can be readily implemented

- Facility upgrades will be required if implementation of a special protection system is determined to be complex, ineffective, the amount of tripping exceeds the current CAISO single and double contingency tripping limitations, or the CAISO does not approve use of a special protection system

- Facility upgrades will also be required if adverse impacts are identified on existing or currently proposed special protection systems

- Congestion management in preparation for the next contingency will be required, with CAISO concurrence, if no facility upgrades or special protection systems are implemented

Congestion Assessment

The following study method was implemented to assess the extent of possible congestion:

a). Under Base Case with all transmission facilities in service, the system was evaluated with all existing interconnected generation and all generation requests in the area that have a queue position ahead of this request (pre-project) and all transmission upgrades necessary to interconnect these queued ahead projects modeled in service

b). Under Base Case with all transmission facilities in service, the system was reevaluated with the inclusion of the SES Solar One Project (post-project)

If the normal loading limits of facilities including new ones modeled to interconnect generation projects ahead in the queue are exceeded in (a), the overload is identified as a "pre-project" overload that was triggered by a project in queue ahead of the SES Solar One Project. If the normal loading limits of facilities are exceeded in (b) and were not exceeded in (a), the overload is identified as triggered with the inclusion of the SES Solar One Project. Overloads identified in (a) should only exist if the CAISO allowed for the use of congestion management as an acceptable means to mitigate identified "pre-project" overloads for queued ahead generation project or if appropriate facility upgrades have not been identified. The SES Solar One Project and other market participants in the area may be subjected to congestion management, potential upgrade cost and/or participation in any proposed special protection system(s) if the inclusion of the SES Solar One Project aggravates or trigger overloads. Additionally, the SES Solar One Project may have to participate in mitigation of overloads triggered by subsequent projects in queue, subject to FERC protocols and policies.

In order for congestion management to be a feasible alternative to system facilities, all of the following factors need to be satisfied:

- Time requirements necessary for coordination and communication between the CAISO operators, scheduling operators and SCE operators
- Distinct Path/Corridor rating should be adequately defined so monitoring and detecting congestion and implementing congestion of the contributing generation resources can be performed when limits are exceeded
- Sufficient amount of market generation in either side of the congested path/corridor should be available to eliminate market power
- Manageable generation in the affected area is necessary so that operators can implement congestion management if required (i.e. the dispatch schedule is known and controllable).

The results of these studies should be able to identify:

- if capacity is available to accommodate the proposed SES Solar One Project and all projects ahead in queue without the need for congestion management, special protection systems, and/or facility upgrades
- if congestion exists in the area with the inclusion of the SES Solar One Project and all projects ahead in queue under single and double element outage conditions assuming no new special protection systems are in place
- if sufficient capacity is maintained to accommodate all Must-Run and Regulatory Must-Take generation resources with all facilities in service
- if sufficient capacity is maintained to accommodate the total output of any one generation resource which is not classified as Must-Run.

The range of base case congestion will be determined by reducing market generation projects in the various areas within the SCE Big Creek Corridor. For single and double element outage conditions, the same methodology will be used to determine how much generation tripping is required in order to determine if use of special protection systems is appropriate. Use of special protection systems will be deemed inappropriate if the total amount of generation reduction is found to exceed 1,150 MW under loss of one transmission element and 1,400 MW under loss of two transmission elements. These limits are established by the CAISO utilizing the current Spinning Reserve Criteria.

B. Generation and Load Assumptions

To simulate the SCE transmission system for analysis, the study used databases that were used to conduct the SCE Annual CAISO Controlled Facilities Expansion

Program. The bulk power study considered scenarios that evaluated maximum North of Lugo area generation and included high imports from the East. In addition, the study considered two load conditions: 2009 heavy summer and 2009 light spring. Generation assumptions are shown in Table 1-1. Heavy summer and light spring load assumptions are provided below in Tables 1-2 and 1-3 respectively.

TABLE 1-1
GENERATION ASSUMPTIONS

North of Lugo Sub-Area	Generation Resource Type	Total MW
Bishop/Control	Bishop Hydro and Geothermal	125
Inyokern	Geothermal	368
Kramer	Gas and Solar	1,113
Victor	Combined Cycle	850
CAISO Queue	Wind	63
CAISO Queue	Geothermal	10
CAISO Queue	Geothermal	62
CAISO Queue	Wind	49.5
SCE WDAT	Wind	81
SCE WDAT	Gas Turbine	15.2 (net)
SCE WDAT	Gas Turbine	32.6 (net)

TABLE 1-1
HEAVY SUMMER LOAD ASSUMPTIONS

SUBSTATION	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ALAMITOS	192	195	188	190	190	192	192	195	197	199	200
ANTELOPE	553	573	591	609	629	651	672	692	718	737	761
BAILEY	79	82	84	87	90	93	96	99	103	105	109
BARRE	693	700	722	728	794	799	809	815	828	841	860
BLYTHE	55	56	57	58	58	59	60	61	63	64	65
CAMINO	2	2	2	2	2	2	2	2	2	2	2
CENTER	487	502	512	521	523	528	533	537	540	548	556
CHEVMAIN	130	130	130	130	130	130	130	130	130	130	130
CHINO	692	715	731	757	773	929	953	979	998	1004	1047
CIMA	2	2	2	2	2	2	2	2	2	2	2
DEL AMO	500	507	524	533	479	482	495	505	521	531	535
DEVERS - MIRAGE	692	724	752	400	355	374	386	397	411	425	440
EAGLE MT.	4	4	4	4	4	4	4	4	4	4	4
EAGLE ROCK	198	200	211	213	215	219	221	223	218	221	224
ELLIS	631	637	646	654	661	667	672	683	688	699	707
EL NIDO	348	353	357	362	367	369	373	378	384	390	395
ETIWANDA	549	567	587	604	621	641	650	687	710	733	757
ETIWANDA "AMERON"	70	70	70	70	70	70	70	70	70	70	70
GOLETA	252	254	258	260	262	264	266	270	275	278	281
GOULD	116	119	116	118	121	122	125	128	131	134	136
HINSON	503	536	545	551	554	592	595	602	612	620	635
JOHANNA	422	430	440	446	454	462	470	480	538	549	566
JURUPA	0	0	0	294	299	304	310	316	324	332	339
KRAMER	217	219	224	227	229	232	235	238	244	249	253
LA CIENEGA	465	471	467	471	475	478	483	488	506	513	519
LA FRESA	705	709	714	716	716	695	700	705	715	722	724
LAGUNA BELL	640	649	659	667	670	675	682	690	705	716	725
LEWIS	546	558	570	586	601	607	613	625	635	644	651
LIGHTHIPE	549	558	571	580	583	589	590	598	605	615	623
MESA	602	606	630	641	645	646	652	661	673	682	692
MIRAGE	0	0	0	378	387	388	398	409	422	434	444
MIRA LOMA	671	705	743	780	807	696	717	737	777	815	833
MOORPARK	641	661	677	692	704	717	730	747	893	912	949
OAK VALLEY	0	0	0	0	162	171	181	194	203	214	226
OLINDA	363	366	375	391	397	408	410	414	430	438	448
PADUA	655	663	676	684	687	692	706	714	726	743	754
RECTOR	688	720	751	773	792	809	826	858	884	904	932
RIO HONDO	740	753	756	766	777	785	791	803	817	832	843
SAN BERNARDINO	580	600	625	634	644	657	671	684	709	723	741
SANTA CLARA	552	568	586	602	614	626	639	654	672	688	706
SANTIAGO	665	684	704	724	741	765	787	812	836	853	877
SAUGUS	682	703	725	751	773	798	824	847	741	768	779
SPRINGVILLE	225	229	237	242	246	252	258	251	258	264	269
VALLEY	1353	1443	1526	1599	1671	1735	1803	1876	1964	2042	2139
VESTAL	183	187	193	196	196	198	199	203	206	210	213
VICTOR	487	501	517	532	540	553	557	573	589	605	620
VIEJO	327	337	348	364	375	384	392	400	412	424	437
VILLA PARK	750	765	761	760	765	763	773	783	749	763	765
VISTA 66 KV	810	828	848	565	566	577	588	599	613	629	612
VISTA 115 KV	442	451	453	475	393	397	398	405	407	416	420
WALNUT	691	697	710	720	726	728	732	739	749	761	770
Total	22,402	22,989	23,573	24,107	24,533	24,977	25,422	25,964	26,604	27,195	27,787

TABLE 1-2
LIGHT SPRING LOAD ASSUMPTIONS

SUBSTATION	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ALAMITOS	125	127	122	123	124	125	125	127	128	129	130
ANTELOPE	360	373	384	396	409	423	437	450	466	479	495
BAILEY	51	53	55	57	58	60	62	64	67	68	71
BARRE	451	455	469	473	516	519	526	530	538	547	559
BLYTHE	36	36	37	37	38	39	39	40	41	42	42
CAMINO	1	1	1	1	1	1	1	1	1	1	1
CENTER	317	327	333	339	340	343	346	349	351	356	361
CHEVMAIN	85	85	85	85	85	85	85	85	85	85	85
CHINO	450	465	475	492	502	604	620	636	649	653	681
CIMA	1	1	1	1	1	1	1	1	1	1	1
DEL AMO	325	330	341	347	311	313	322	329	338	345	348
DEVERS - MIRAGE	450	471	489	260	231	243	251	258	267	276	286
EAGLE MT.	3	3	3	3	3	3	3	3	3	3	3
EAGLE ROCK	129	130	137	136	140	143	144	145	142	144	146
ELLIS	410	414	420	425	430	433	437	444	447	454	460
EL NIDO	226	229	232	235	238	240	242	245	250	253	257
ETIWANDA	357	369	381	392	404	417	423	447	461	476	492
ETIWANDA "AMERON"	70	70	70	70	70	70	70	70	70	70	70
GOLETA	164	165	167	169	170	171	173	175	179	181	183
GOULD	76	77	76	77	79	80	81	83	85	87	89
HINSON	327	348	354	358	360	385	387	391	398	403	413
JOHANNA	274	279	286	290	295	300	305	312	350	357	368
JURUPA	0	0	0	191	195	198	201	206	211	216	220
KRAMER	141	143	145	147	149	151	153	155	158	162	164
LA CIENEGA	303	306	304	306	309	311	314	317	329	333	337
LA FRESA	458	461	464	465	466	452	455	458	464	469	471
LAGUNA BELL	416	422	429	434	435	439	443	448	458	465	472
LEWIS	355	363	370	381	391	395	398	406	413	419	423
LIGHTHIPE	357	363	371	377	379	383	384	389	393	400	405
MESA	391	394	410	416	419	420	424	430	437	443	450
MIRAGE	0	0	0	246	252	252	258	266	274	282	289
MIRA LOMA	436	458	483	507	524	453	466	479	505	530	542
MOORPARK	417	430	440	450	457	466	475	486	580	593	617
OAK VALLEY	0	0	0	0	105	111	117	126	132	139	147
OLINDA	236	238	244	254	258	265	267	269	279	285	291
PADUA	426	431	440	445	446	450	459	464	472	483	490
RECTOR	447	468	488	502	515	526	537	558	574	588	605
RIO HONDO	481	489	491	498	505	510	514	522	531	541	548
SAN BERNARDINO	377	390	407	412	419	427	436	445	461	470	482
SANTA CLARA	359	369	381	391	399	407	416	425	437	447	459
SANTIAGO	432	445	458	471	482	497	512	527	543	554	570
SAUGUS	443	457	471	488	502	519	536	551	482	499	506
SPRINGVILLE	146	149	154	157	160	164	167	163	168	172	175
VALLEY	880	938	992	1040	1086	1128	1172	1219	1276	1327	1390
VESTAL	119	121	125	127	128	128	130	132	134	136	139
VICTOR	317	326	336	346	351	359	362	373	383	393	403
VIEJO	213	219	226	237	243	250	255	260	268	276	284
VILLA PARK	487	497	494	494	497	496	502	509	487	496	497
VISTA 66 KV	527	538	551	367	368	375	382	389	398	409	398
VISTA 115 KV	287	293	285	309	256	258	258	263	265	270	273
WALNUT	449	453	461	468	472	473	476	481	487	495	500
Total	14,586	14,967	15,347	15,694	15,971	16,259	16,549	16,901	17,317	17,701	18,086

C. Transmission Projects

Generation interconnection requests in the North of Lugo Area ahead of the SES Solar One Project have triggered the need for additional transmission projects in the North of Lugo Area. These upgrades include new transmission facilities from the SCE Lugo 230 kV Substation to the SCE Kramer 230 kV Substation, conversion of the existing Inyokern 115 kV substation to 230 kV with two 230/115 kV transformers, increase in line operating voltage as well as minor rearrangements, upgrades to the Inyo phase-shift transformer, a third Lugo 500/230 kV transformer bank and reconductor of existing 115 kV line between Mountain Pass and El Dorado. Applications for Certificates of Public Convenience and Necessity (CPCN) will be required to permit a number of these transmission upgrades with the California Public Utilities Commission (CPUC). Studies were conducted without and with the inclusion of such pre-project upgrades with the results summarized in Section III.B. A discussion of each transmission upgrade required to mitigate pre-project identified overload criteria violations follows:

Upgrade to Inyo 115 kV Phase-Shift Transformer

The upgrade involved replacement of the phase-shift transformer at Inyo with a new one that has greater phase-shift capability.

Inyokern Substation Conversion to 230 kV

The facility upgrades involve a new Inyokern 230 kV substation and utilization of existing 230 kV transmission facilities. With this new substation in place, the existing Kramer-BLM West 230 kV transmission line can be looped in and out of the new substation forming the new Kramer-Inyokern 230 kV and Inyokern-BLM West 230 kV transmission lines. In addition, an existing 230 kV transmission line currently energized at 115 kV is recommended to be upgraded to 230 kV operations. This requires moving the existing Randsburg 115 kV connecting point to the existing Kramer-Inyokern No.3 115kV line and operating this line as a preferred / emergency (P/E) connection normally served from Kramer.

New Lugo-Kramer Transmission Line Project

The facility involves the construction of a new Kramer-Lugo 230 kV transmission line.

Third Lugo 500 / 230 kV Transformer Bank

The facility involves installing a third Lugo 500/230 kV transformer bank.

Mountain Pass-El Dorado 115 kV line reconductor

The facility involves reconductoring of an existing 115 kV line with a larger conductor line.

El Dorado 230/115 kV transformer bank

The facility involves replacing existing 230/115 kV transformer bank with a larger size.

D. SES Solar One Project

The proposed SES Solar One Project consists of 34,000 solar dish sterling systems grouped into 680 1.25 MW groups and spread throughout an estimated nine square-miles and proposed to be constructed over a period of four to five years beginning in 2009. The SES Solar One Project is located approximately two miles north of the existing SCE Pisgah 230 kV Substation, which is a 230 kV switching station connecting two 230 kV transmission lines from El Dorado and two 230 kV transmission lines from Lugo. The developer proposes to construct new 230 kV generation dedicated transmission (gen-tie) and substation facilities and connect the SES Solar One Project radial to the Pisgah 230 kV substation. The gen-tie facilities include three new 230 kV Substations connected radial to a single 230 kV transmission line which connects to Pisgah as shown below in Figure 1-1. Each of the three substations will have two 230/34.5 kV transformers with twelve distribution feeders, six per transformer bank as shown below in Figure 1-2. Connected to each 34.5 kV distribution feeder are nineteen 1.25 MW solar groups made of five 25 kW sterling dish systems or a total of 23.75 MW as shown in Figure 1-3. Customer provided data is included in Appendix E and F for information.

FIGURE 1-1
SES SOLAR ONE PROJECT
BULK TRANSMISSION SYSTEM ONE-LINE DIAGRAM

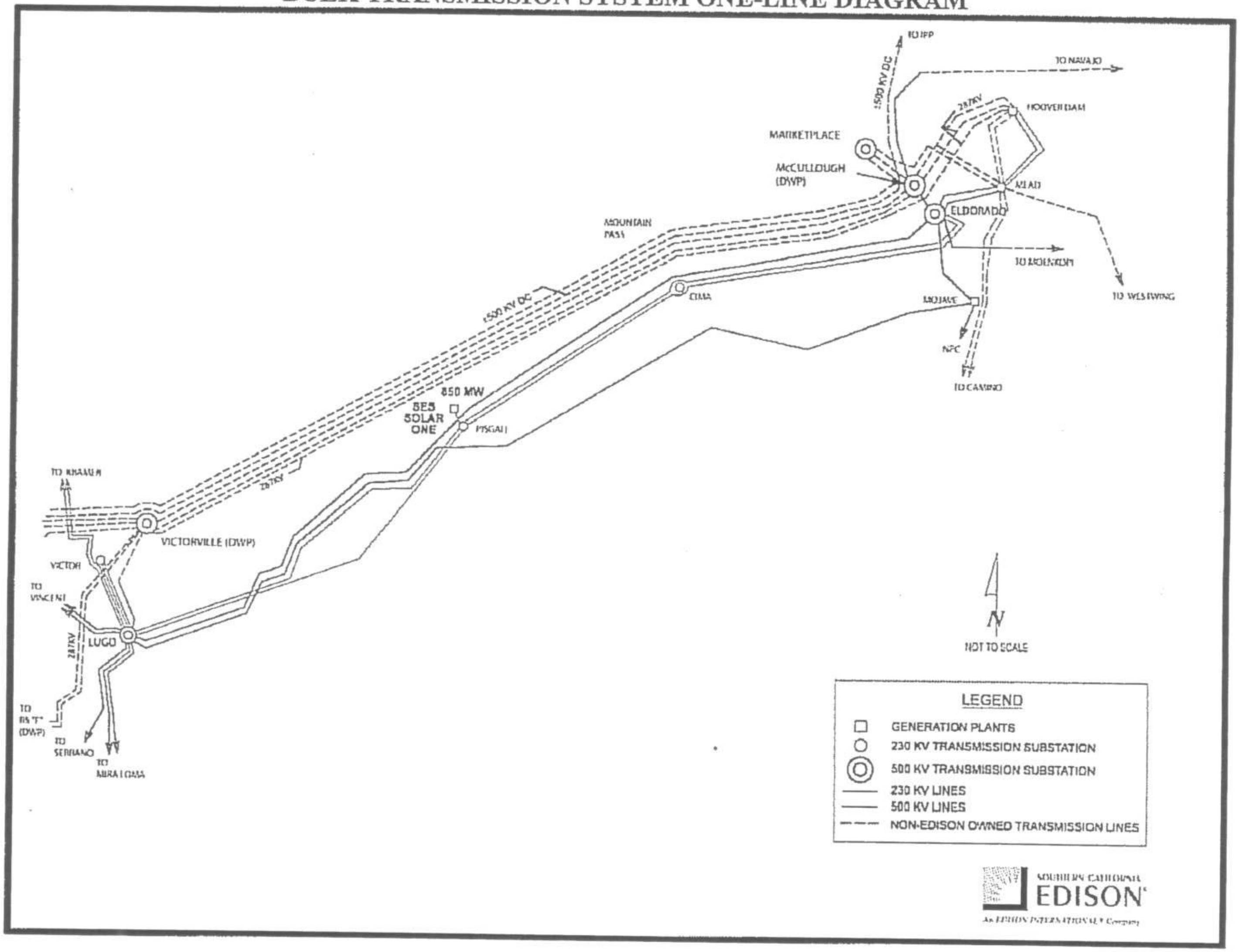


FIGURE 1-2
SES SOLAR ONE PROJECT
230 kV COLLECTOR SUBSTATION ONE-LINE DIAGRAM

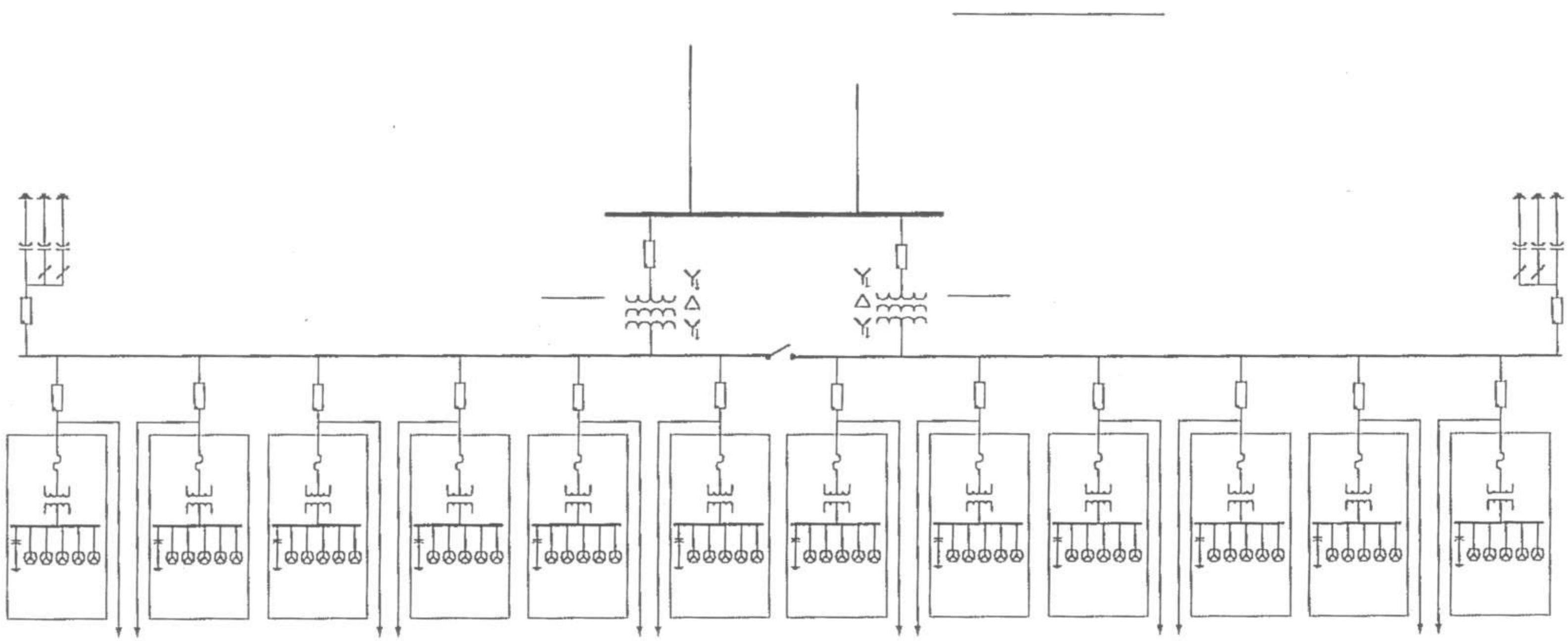


FIGURE 1-3
SES SOLAR ONE PROJECT
34.5 kV DISTRIBUTION FEEDER ONE-LINE DIAGRAM

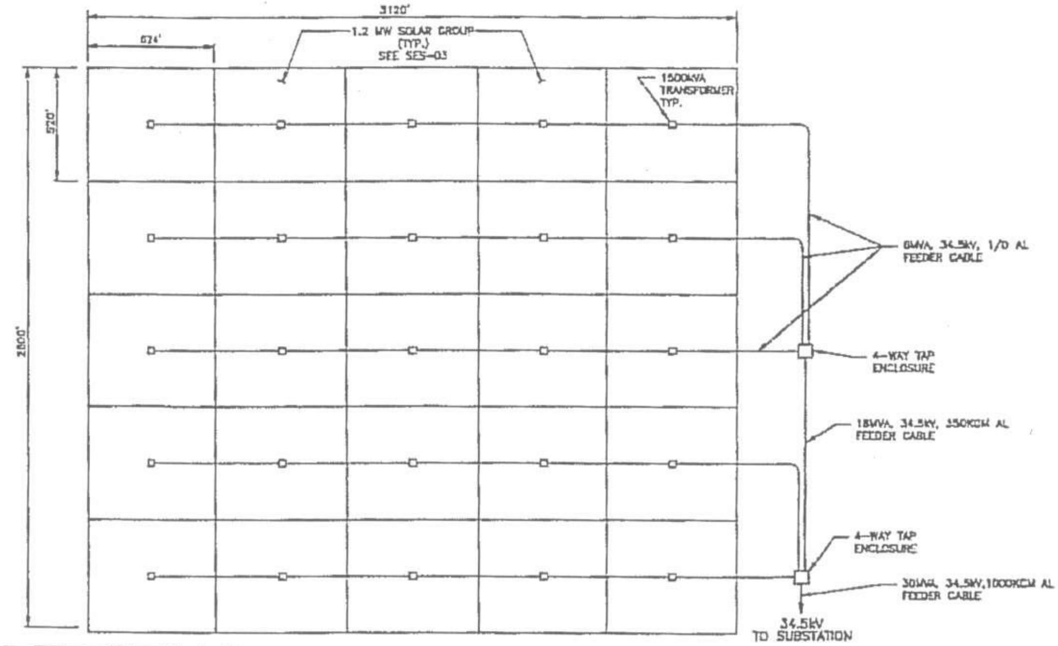
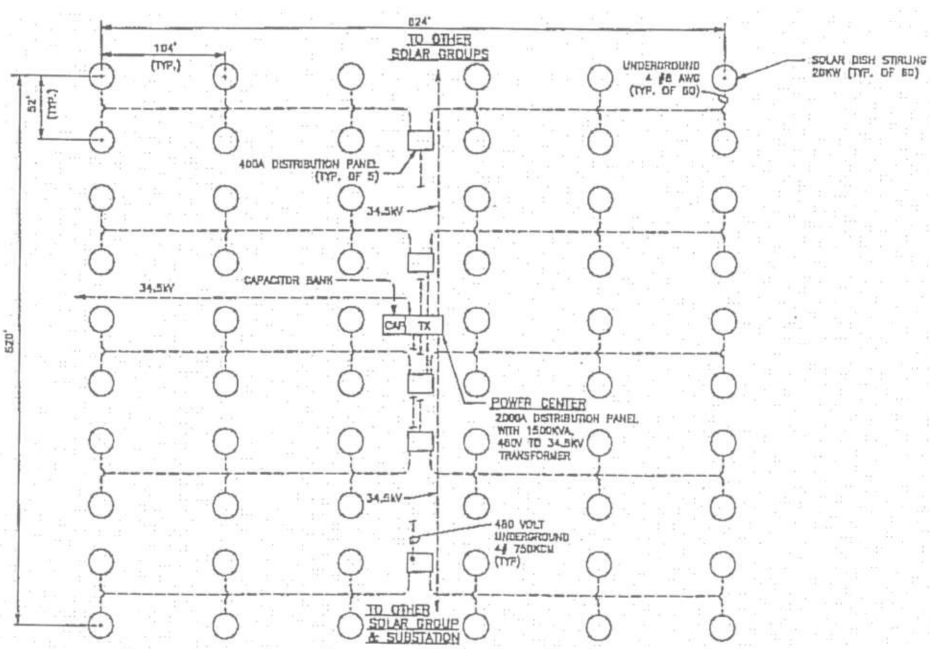


FIGURE 1-4
SES SOLAR ONE PROJECT
1.25 MW SOLAR CLUSTERS



The solar dish sterling systems utilize sterling engines rated 25 kW at 1800 RPM. The generator consists of a 3-phase 460 Volt induction generation unit. Each induction generator operates at a power factor ranging from 0.5 at 25% of the rated power to 0.84 at full rated power if uncompensated. The induction generator and their prime movers (Sterling engines) do not have controls that respond to system frequency or voltage fluctuations. Therefore, only the induction generator dynamic model was developed by GE Energy and provided to SCE by SES for use in conducting the transient stability analysis. Shown below in Table 1-4 are the corresponding Induction Generator Data.

TABLE 1-4
INDUCTION GENERATOR MOTOR1 MODEL

Variable	Value	Description
L_s	2.240	Synchronous reactance, per-unit
L'	0.200	Transient reactance, per-unit
R_a	0.015	Stator Resistance, per-unit
T'_o	1.430	Transient rotor time constant, second
H	0.120	Inertia constant, second
D	0.000	Damping factor, per-unit
S_{e1}	0.164	Saturation factor at 1 per-unit flux
S_{e2}	0.894	Saturation factor at 1.2 per-unit flux
V_T	0.150	Voltage threshold for tripping, per-unit
T_V	0.000	Voltage trip pickup time, second
F_T	0.000	Frequency threshold for tripping, Hertz
T_F	999.0	Frequency trip pickup time, second
V_r	1.200	Voltage at which reconnection is permitted, per-unit
T_{vr}	999.0	Time delay for reconnection, seconds
Acc	0.300	Acceleration factor for initialization
L"	0.130	Sub-transient reactance, per-unit
L_l	0.120	Stator leakage reactance, per-unit
L''_o	0.008	Sub-transient rotor time constant

The inclusion of the SES Solar One Project will increase flows on the two 230-kV transmission lines connecting the existing SCE Pisgah 230 kV Substation to the SCE Lugo 230 kV Substation. The project is also anticipated to impact flows on the Lugo AA-Banks. Existing ratings for these transformer banks (MVA) and transmission lines (amps) are provided below in Table 1-5.

TABLE 1-5
TRANSMISSION LINE AMPACITY and TRANSFORMER MVA CAPACITY

Transmission Line	Normal	Emergency (Amps)
Lugo-Pisgah No.1 230-kV	725 (Amps)	725 (Amps)
Lugo-Pisgah No.2 230-kV	725 (Amps)	725 (Amps)
Lugo No.1 500/230-kV Transformer	1120 (MVA)	1230 (MVA)
Lugo No.2 500/230-kV Transformer	1120 (MVA)	1230 (MVA)

E. **Bishop Remedial Action Scheme**

The Bishop Remedial Action Scheme is designed to prevent system instability in the Bishop area by tripping local generation for the loss of both the Control-Haiwee-Inyokern No.1 and No.2 115 kV lines or for the loss of a single Control-Haiwee-Inyokern 115 kV line when the SCE/LADWP Inyo 230 kV Intertie is open.

In addition to tripping local generation under outage condition, SCE System Operating Bulletin No.214 allows for curtailment of generation in the Bishop Area to minimize flows on the Inyo phase-shift transformer or to eliminate overloads.

The Bishop RAS arming is based on Control-Haiwee-Inyokern No.1 and No.2 115 kV line flows. Adding generation in the area may result in changes to existing line flows and may adversely affect the current arming levels.

F. **Kramer Remedial Action Scheme**

The Kramer Remedial Action Scheme is designed to prevent transmission line or transformer bank overloads as well as system instability. These problems could occur during high generation conditions under certain transmission component outages. The following outlines the outages that can result in the potential operation of the Kramer RAS:

Single Outages

1. Loss of Kramer-Inyokern-Randsburg No.1 115 kV Line
2. Loss of Kramer-Lugo No.1 230 kV Transmission Line
3. Loss of Kramer-Lugo No.2 230 kV Transmission Line

Double Outages

1. Loss of Kramer-Lugo No.1 and No.2 230 kV Transmission Lines
2. Loss of Lugo 500/230 kV No.1 and No.2 Transformer Banks (Safety Net)

In addition to tripping generation under outage conditions, SCE System Operating Bulletin No.209 allows for curtailment of generation in the Inyokern Area when the 115 kV portion of the Remedial Action Scheme is inoperative. SCE System Operating Bulletin No.209 also allows for curtailment of generation in the Kramer area when the 230 kV portion of the Remedial Action Scheme is inoperative.

Arming of the 115 kV Kramer RAS portion is based on Kramer-Inyokern-Randsburg No.3 115 kV line flow while arming of the 230 kV Kramer RAS portion is based on Kramer-Lugo No.1 and No.2 230 kV line flows. The "Safety Net" is armed based on the sum flows of the two Lugo AA-Banks. Adding generation north of Lugo may result in changes to existing line flows and may adversely affect the current arming levels.

G. High Desert Power Project Remedial Action Scheme

The High Desert Power Project (HDPP) Remedial Action Scheme is designed to prevent transmission line or transformer bank overloads as well as system instability. These problems could occur during high generation conditions under certain transmission component outages. The following outlines the outages that can result in the potential operation of the HDPP RAS:

Single Outages

1. Loss of Lugo-Victor No.1 230 kV Transmission Line
2. Loss of Lugo-Victor No.2 230 kV Transmission Line
3. Loss of Lugo 500/230 No.1 Transformer Bank (AA-Bank)
4. Loss of Lugo 500/230 No.2 Transformer Bank (AA-Bank)

Double Outages

1. Loss of Lugo-Victor No.1 and No.2 230 kV Transmission Lines
2. Loss of Lugo 500/230 kV No.1 and No.2 Transformer Banks ("Safety Net")

In addition to tripping generation under outage conditions, SCE System Operating Bulletin No.283 allows for curtailment of generation in the Victor Area when the Remedial Action Scheme is inoperative.

Arming of the HDPP RAS is based on Lugo-Victor No.1 and No.2 230 kV line flows as well as Lugo AA-Bank flows. The "Safety Net" is armed based on the sum flows of the two Lugo AA-Banks. Adding generation north of Lugo may result in changes to existing line flows and may adversely affect the current arming levels.

H. Power Flow Study

The system impact studies evaluated different power flow study scenarios. Further description of the study case assumptions follows:

1. North of Lugo 2009 heavy summer with all currently planned and approved transmission upgrades and generation projects in queue ahead of the SES Solar One Project, Case 1 – Pre-Project Heavy Summer.

North of Lugo system with a 2009 heavy summer load forecast with high internal generation in the SCE north of Lugo electrical system. Generation included: Year 2004 reliability must-run, regulatory must-take, all existing generation in the basin area, and all other proposed generation projects in queue ahead of the proposed SES Solar One Project. Generation patterns were maximized in the SCE northern area in order to identify extent of potential congestion after the in-service of the proposed project.

2. North of Lugo 2009 heavy summer with all currently planned and approved transmission upgrades and the inclusion of the SES Solar One Project,
   Case 2 – Post-Project Heavy Summer without upgrades triggered by project

   Case 1 was modified to include the SES Solar One Project. South of Lugo flow was not enforced in order to determine project contribution to the South of Lugo loading problem.

3. North of Lugo 2009 light spring with all currently planned and approved transmission upgrades and generation projects in queue ahead of the SES Solar One Project,
   Case 3 – Pre-Project Light Spring

   North of Lugo system with a 2006 light spring load forecast with high internal generation in the SCE north of Lugo electrical system. Generation included: Year 2004 reliability must-run, regulatory must-take, all existing generation in the basin area, and all other proposed generation projects in queue ahead of the proposed SES Solar One Project. Generation patterns were maximized in the SCE northern area in order to identify the extent of potential congestion after the in-service of the proposed project.

4. North of Lugo under 2009 light spring with all currently planned transmission upgrades and the inclusion of the SES Solar One Project,
   Case 4 – Post-Project Light Spring without upgrades triggered by project

   Case 3 was modified to include the SES Solar One Project.

5 - 6. Cases 2 and 4 were modified to include initial facility upgrades to interconnect and deliver the SES Solar One Project.

7 - 8. Cases 2 and 4 were modified to include initial and final facility upgrades identified as necessary to interconnect and deliver the SES Solar One Project.

Table 1-6 provides a summary of SCE area load and generation case assumptions as well as major specific path flow patterns for the existing system arrangement. Table 1-7 provides a summary of SCE area load and generation case assumptions as well as major specific path flow patterns with an upgraded system to mitigate overload criteria violations triggered by the SES Solar One Project.

TABLE 1-6
POWER FLOW STUDY ASSUMPTIONS (MW)
INCLUDING UPGRADES TO MITIGATE OVERLOADS
TRIGGERED BY PROJECTS IN QUEUE AHEAD OF SES SOLAR ONE

	Heavy Summer		**Light Spring**	
Area Assumptions	**Case 1: Pre**	**Case 2: Post**	**Case 3: Pre**	**Case 4: Post**
Generation	14,785	14,835	8,840	9,757
Import	10,789	10,790	7,985	7,135
Load	24,896	24,896	16,267	16,267
System Losses	678	729	559	625
Path Flows				
Inyo Phase-Shift	3	8	14	19
South of Kramer	1,122	1,124	1,165	1,159
East-of-River	7,546	7,536	8,131	8,058
West-of-River	8,816	8,794	8,693	8,592
South of Lugo	5,677	5,724	3,861	3,863
SCIT	16,226	16,222	14,403	13,551

TABLE 1-7
POWER FLOW STUDY ASSUMPTIONS (MW)
INCLUDING UPGRADES TO MITIGATE OVERLOADS
TRIGGERED BY THE SES SOLAR ONE PROJECT

	Heavy Summer		**Light Spring**	
Area Assumptions	**Case 5: Initial**	**Case 7: Final**	**Case 6: Initial**	**Case 8: Final**
Generation	14,787	14,787	9,715	9,709
Import	10,790	10,790	7,135	7,134
Load	24,896	24,896	16,267	16,267
System Losses	681	682	583	576
Path Flows				
Inyo Phase-Shift	5	5	15	15
Kramer-Lugo	1,130	1,130	1,164	1,164
East-of-River	7,533	7,534	8,059	8,060
West-of-River	8,806	8,808	8,604	8,610
South of Lugo	5,801	5,804	3,930	3,945
SCIT	16,222	15,164	13,553	12,488

I. Transient Stability Study

Transient stability studies were conducted for the critical single and double contingencies north of Lugo listed below in Table 1-8 and Table 1-9 respectively. All outage cases were initially evaluated without implementation of the existing special protection schemes (SPS) or remedial action schemes (RAS). For those contingencies that were found to be unstable, additional review was performed to identify if the contingency has an existing SPS or RAS in place or if one was previously recommended as part of a generation interconnection study for a projected in queue ahead of the SES Solar One Project. Those contingencies that presently trigger a RAS were reevaluated without tripping the SES Solar One Project to identify if the SES Solar One Project has an adverse impact on the existing RAS. Tripping of the SES Solar One Project was included if stability studies indicate that additional RAS is required.

TABLE 1-8
SINGLE CONTINGENCY TRANSIENT STABILITY CRITICAL STUDY CASES

Bus Fault Location	Fault	Duration	Transmission Outage
Pisgah 230 kV	3θ	5 cycles	Lugo-Pisgah No.1 230 kV Line
El Dorado 230 kV	3θ	5 cycles	El Dorado-Pisgah No.1 230 kV Line
Lugo 230 kV	3θ	4 cycles	Lugo 500/230 kV No.1 Transformer
El Dorado 500 kV	3θ	4 cycles	El Dorado-Lugo 500 kV T/L
Lugo 500 kV	3θ	4 cycles	Lugo-Mohave 500 kV T/L
Lugo 500 kV	3θ	4 cycles	Lugo-Mira Loma No.1 500 kV T/L
Lugo 500 kV	3θ	4 cycles	Lugo-Vincent No.1 500 kV T/L

TABLE 1-9
DOUBLE CONTINGENCY TRANSIENT STABILITY CRITICAL STUDY CASES

Bus Fault Location	Fault	Duration	Transmission Outage
Pisgah 230 kV	1θ	5 cycles	Lugo-Pisgah No.1 230 kV and Lugo-Pisgah No.2 230 kV T/Ls
Pisgah 230 kV	1θ	5 cycles	El Dorado-Pisgah No.2 and El Dorado-Pisgah-Cima No.1 230 kV T/Ls

The project addition was found to result in minimal change in flows between Kramer and Lugo as shown above in Table 1-6 and Table 1-7. As such, transient stability analysis for transmission outages between Lugo and Victor and between Lugo and Kramer were not examined because the project impacts should be minimal.

J. Post-Transient Study

The power flow study voltage results were used as a screen to identify those contingencies that may require additional post-transient voltage studies. Single and double contingencies identified in the power flow to have a voltage drop in excess of 5% were selected for post-transient simulation.

K. Short-Circuit Duty Study

To determine the impact on short-circuit duty after inclusion of the SES Solar One Project, the study calculated the maximum symmetrical three-phase-to-ground short-circuit duties at the most critical locations. Bus locations where short-circuit duty is increased with the SES Solar One Project by at least 0.1 kA and the duty is in excess of 60% of the minimum breaker nameplate rating are flagged for further review. Generator and transformer data as provided by the customer was used according to the generator and transformer data sheets.

L. Cost Estimates

Conceptual studies previously performed for integrating renewable resources north of the SCE Lugo substation examined transmission requirements necessary to interconnect and deliver energy to the SCE load center (LA Basin). These studies included conceptual cost estimates derived from standard off-the-shelf unit-cost guides. To the extent any of the upgrades identified in this study are the same as those evaluated in the conceptual studies, the cost estimates derived for the conceptual studies will be updated and used as a **non-binding** cost estimate. Cost of facilities not previously estimated will be estimated utilizing standard off-the-shelf unit-cost guides.

M. Project Timelines

Timelines for new projects will be based on a number of factors. For the most part, the driving factors include the following:

- Time requirements to prepare the Proponents Environmental Assessment (PEA) in support of an application for a Certificate of Public Convenience and Necessity (CPCN) or Permit to Construct (PTC)
- CPCN or PTC Application review and approval process
- Estimated material acquisition lead times
- Construction of facilities

III. STUDY RESULTS

A. Power Factor Correction Study Results

The generator power factor design result in a reactive demand that ranges from 365 MVAR to 550 MVAR, without additional power factor correction. This demand requirement excludes transformation and local collector distribution reactive losses and results in a degradation of voltages throughout the system. Shown below in Figure 2-1 and Figure 2-2 is the Pisgah 230 kV bus voltage as a function of SES Solar One Project output. Figure 2-1 was derived by adding incremental solar dish sterling systems and dispatching them at 25% of the rated power with a power factor of 0.50. Figure 2-2 was derived by adding incremental solar dish sterling systems and dispatching them at full rated power with a power factor of 0.84.

Figure 2-1
Impact to Pisgah 230 kV Bus Voltage
Based on Uncompensated Power Factor of 0.50 at 25% Output

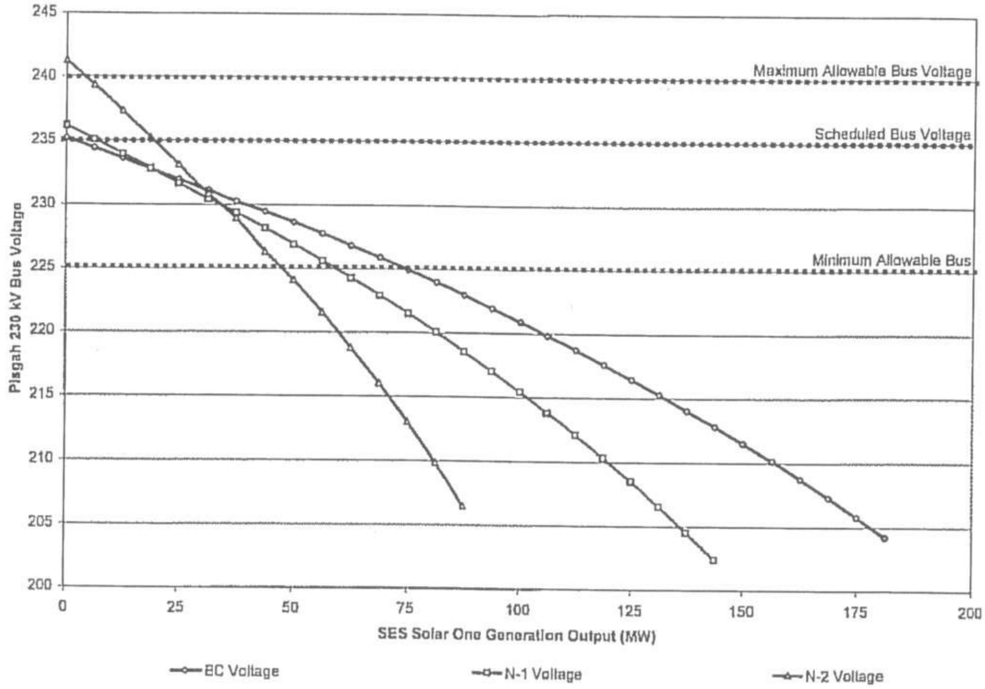
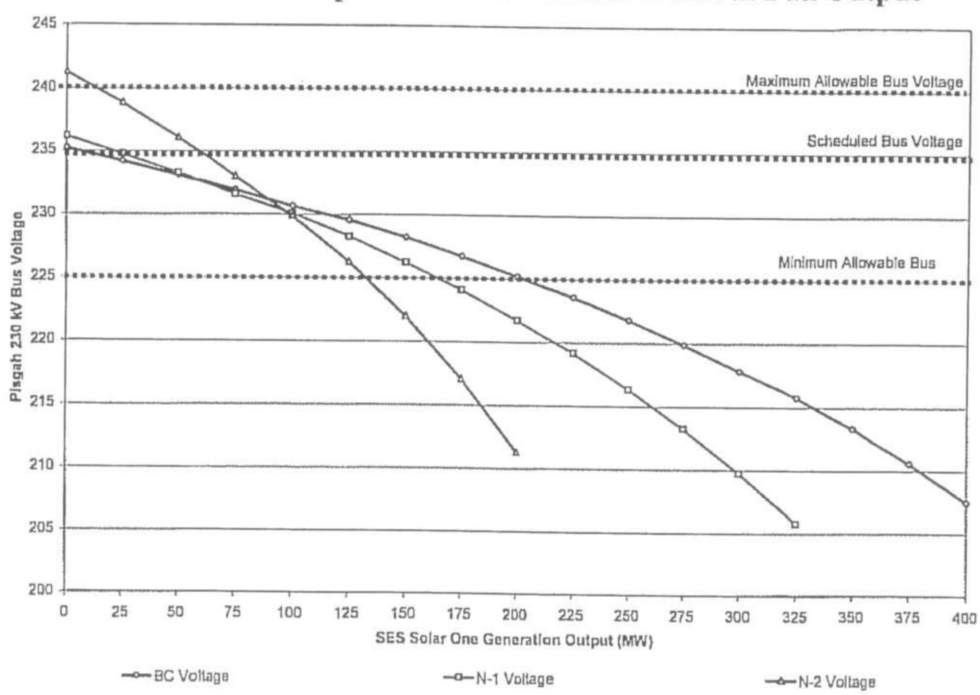


Figure 2-2
Impact to Pisgah 230 kV Bus Voltage
Based on Uncompensated Power Factor of 0.84 at Full Output



The addition of the SES Solar One Project adversely impacts SCE's ability to maintain scheduled voltages if power factor correction is not placed at strategic locations. For generation levels ranging up to 400 MW, the amount of SES Solar One Project uncompensated reactive demands vary between 0 and 350 MVAR as shown below in Figure 2-3 and Figure 2-4. Of the 350 MVAR reactive demands, approximately 260 MVAR are associated with the reactive loads at 0.84 pf (full rated output) and the remaining 90 MVAR are associated with transformation and local distribution collector losses. Without power factor correction, the reactive requirements are transmitted from other generation resources. Such transmission of reactive power can potentially result in voltage collapse conditions. This condition was identified for the SES Solar One Project when generation levels exceed 400 MW under normal operating conditions, 325 MW under loss of one transmission line, and 200 MW under loss of two transmission lines.

Following good utility practice protocols, power factor correction devices (shunt capacitor banks, substation capacitor banks, or other reactive resource devices) should be located where they are needed, within the SES Solar One Project. The amount of reactive power factor correction is shown below in Figure 2-5. Sensitivity studies were conducted assuming the SES Solar One Project improves power factor to unity. Under conditions with all facilities in service, voltage at the Pisgah 230 kV bus was found to increase when the total SES Solar One Project is less than 150 MW at which point the Pisgah 230 kV bus voltage begins to reduce. This finding indicates that the project must be able to buck under certain operating conditions and the reactive resources should be dynamic in nature. When the project exceeds 350 MW, the study identified that the Pisgah 230 kV bus voltage drops below the scheduled bus voltage. These findings are provided below in Figure 2-5.

Figure 2-3
SES MVAR Demand Including Project Transformation Losses Based on Uncompensated Power Factor of 0.50 at 25% Output

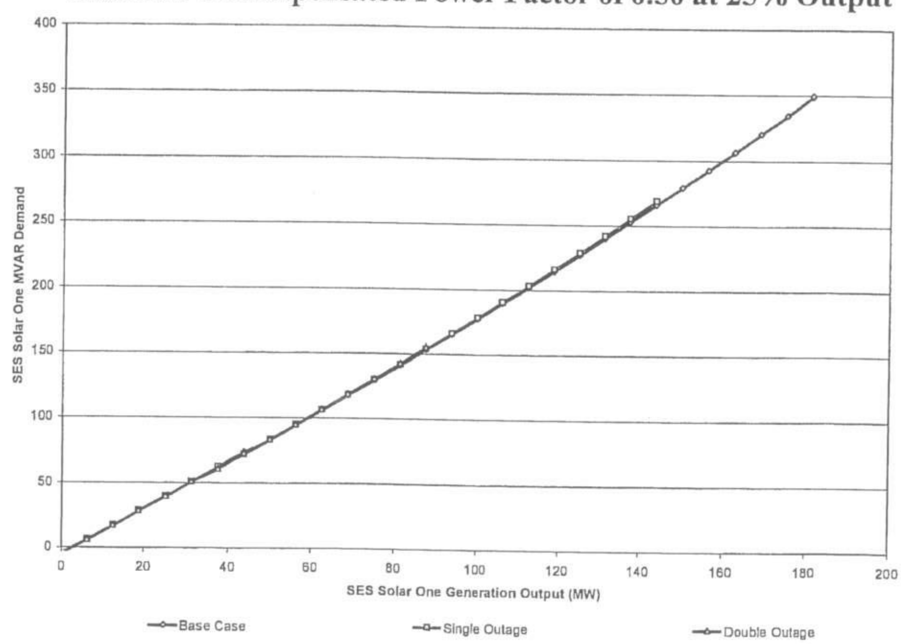


Figure 2-4
SES MVAR Demand Including Project Transformation Losses
Based on Uncompensated Power Factor of 0.84 at Full Output

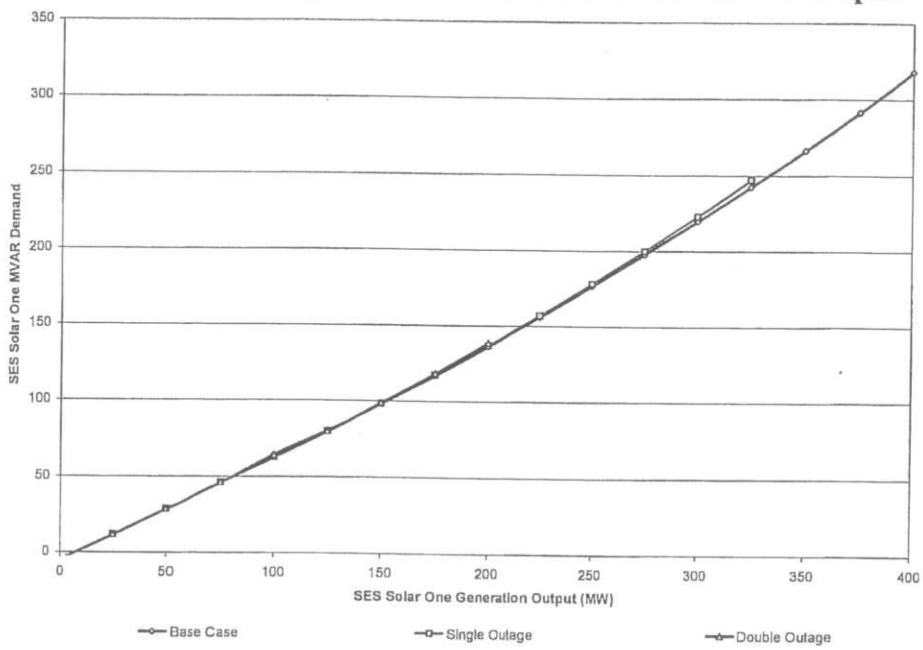
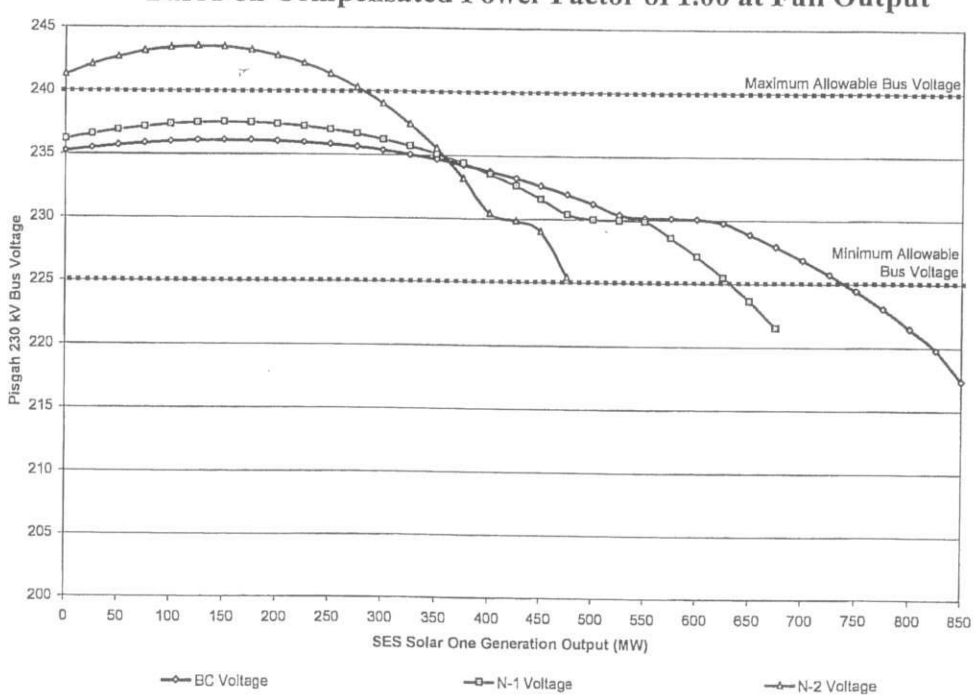
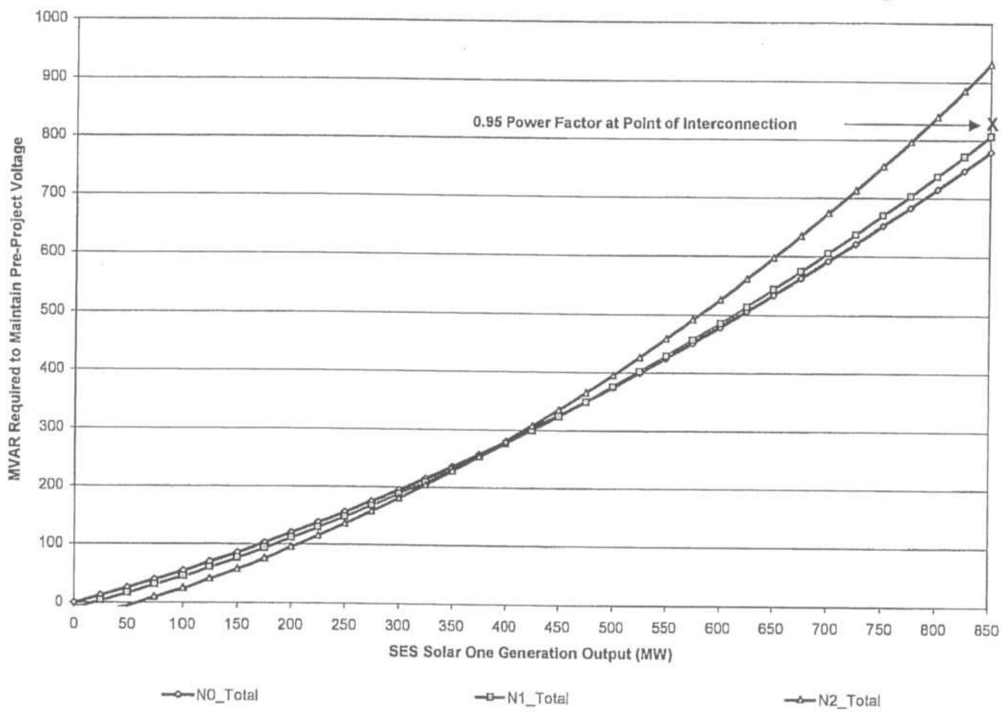


Figure 2-5
Impact to Pisgah 230 kV Bus Voltage
Based on Compensated Power Factor of 1.00 at Full Output



In addition, a comprehensive study was conducted to determine the amount of reactive support required by the SES Solar One Project in order to maintain scheduled bus voltages. Results of this study are provided in Figure 2-6. As can be seen, under normal conditions with all facilities in service (N-0) and maximum SES Solar One Project output, the amount of reactive support needed to maintain scheduled bus voltage is 780 MVARs. Under loss of one transmission line (N-1), the amount of reactive support needed was identified to be approximately 810 MVARs. Under loss of two transmission lines (N-2), the amount of reactive support needed was identified to be approximately 930 MVARs. In all cases, generation consumption accounts for 550 MVAR of the total requirements and reactive losses makes up the difference. Also shown in Figure 2-6 is the reactive support that a 0.95 power factor lead would provide.

Figure 2-6
Required Reactive Support to Maintain Scheduled Bus Voltage
Based on Uncompensated Power Factor of 0.84 at Full Output



Based on the power factor correction study results, SCE will require the SES Solar One Project to be able to provide reactive support corresponding to a 0.95 power factor boost and the project must be able to buck under certain operating conditions. In addition, the reactive resources should be dynamic in nature. All subsequent power flow studies performed to examine project impacts under outage conditions, assumed the SES Solar One Project was operating at unity power factor.

B. Power Flow Study Results – Without and With Pre Project Upgrades Included in Base Case

Previous generation interconnection studies identified thermal loadings in excess of the allowable thermal limits on a number of transmission facilities located in the North of Lugo area. Loading of these facilities, both pre and post project, are summarized below in Table 2-1. As can be seen, the addition of the SES Solar One Project was found to aggravate loadings on two of the previously identified overloaded facilities. The remaining four previously identified overloaded facilities were not adversely impacted with the addition of the SES Solar One Project.

Table 2-1
Base Case Overloads on Existing System

	Heavy Summer		Light Spring	
Transmission Facility	**Pre**	**Post**	**Pre**	**Post**
Inyo Phase-Shift Xfrm	127%	128%	138%	140%
Mountain Pass-El Dorado 115 kV Line	121%	121%	135%	135%
El Dorado 230 / 115 kV Xfrm	93%	93%	111%	111%
Lugo-Kramer No.1 or No.2 230 kV T/L	103%	103%	109%	109%
Kramer-Inyokern No.3 115 kV T/L	107%	107%	104%	104%

Since the addition of the SES Solar One Project increases loading on the Inyo phase-shift transformer bank by only 2% under light spring conditions and 1% under heavy load conditions, the SES Solar One Project incremental contribution to base case thermal overloads triggered by generation projects in queued ahead is minimal. Consequently, additional studies were conducted to examine the SES Solar One Project upgrade requirements assuming that the base case criteria violations triggered by project additions in queue ahead of the SES Solar One Project were mitigated. In other words, facility upgrades needed to mitigate pre-project criteria violations were included into the study cases prior to addition the SES Solar One Project. These facility upgrades are discussed in Section II.C. Subsequent studies were conducted to determine need for additional facilities triggered by the addition of the SES Solar One Project.

The following presents the power flow study results with the inclusion of transmission projects needed to mitigate pre-project overloads. Power flow plots are provided in Appendix A (Heavy Summer) and Appendix B (Light Spring). Details of heavy summer results are provided in Table 3-1 while Light Spring results are provided in Table 3-2.

BASE CASE

With the addition of the SES Solar One Project, South of Lugo loading was found to be increased by approximately 50 MW under generation redispatch conditions that minimize the increases to South of Lugo. Different generation redispatch patterns will result in additional increases to the total South of Lugo flow further supporting the need for the SCE

Vincent-Mira Loma 500 kV transmission line project (O.D 2011). This upgrade was not modeled in these studies but will increase the total imports into the Mira Loma area.

With the addition of the SES Solar One, the study identified two 230 kV transmission lines and two 500/230 kV transformer banks with base case overloads during heavy summer and light spring load conditions. These overloads are summarized below in Table 2-2.

Table 2-2
Base Case Overloads with Pre-Project Upgrades

	Heavy Summer		Light Spring	
Impacted Transmission Lines	**Pre**	**Post**	**Pre**	**Post**
Lugo-Pisgah No.1 230 kV T/L	25%	121%	19%	114%
Lugo-Pisgah No.2 230 kV T/L	25%	121%	19%	113%
Lugo No.1 500/230 kV Xfrm	87%	115%	96%	119%
Lugo No.2 500/230 kV Xfrm	86%	114%	95%	118%

Sensitivity studies were conducted to identify the SES Solar One Project level that would mitigate thermal overloads on the Lugo-Pisgah 230 kV T/Ls. The study found that the SES Solar One Project should be reduced down to 687 MW and 750 MW for Heavy Summer and Light Spring load conditions respectively to eliminate thermal overloads on these transmission lines. However, this reduction in generation does not mitigate the thermal overloads identified on the Lugo No.1 and Lugo No.2 500/230-kV Transformer Banks. In order to mitigate the thermal overload on the transformer banks as shown in Table 2-3, the SES Solar One Project needs to be reduced down to 300 MW and 150 MW for Heavy Summer and Light Spring Load conditions respectively.

Table 2-3
Base Case Overloads with Pre-Project Upgrades
Reduced SES Solar One Project Output

	Heavy Summer SES at 687 MW		Light Spring SES at 750 MW	
Impacted Transmission Lines	**Pre**	**Post**	**Pre**	**Post**
Lugo No.1 500/230 kV Xfrm	87%	110%	96%	116%
Lugo No.2 500/230 kV Xfrm	86%	109%	95%	115%

SINGLE OUTAGE CONTINGENCY (N-1 or T-1)

Both Lugo-Pisgah 230 transmission lines are line clearance limited and consequently do not have any emergency loading capability. As a result, numerous outage contingencies result in thermal loadings in excess of allowable limits. The worst single contingency was identified to be loss of one Lugo-Pisgah 230 kV transmission line. Under this outage condition, the power flow cases do not converge without additional power factor correction (beyond unity assumed in this study). In addition to the Lugo-Pisgah 230 kV thermal overload problems, power flow studies identified that loss of one Lugo 500/230-kV transformer bank will further limit the amount of SES Solar One Project that can potentially be interconnected without significant facility upgrades, contingent on CAISO approval of temporary interconnection. Outage of one Lugo 500/230 kV transformer bank, results in overloading the remaining Lugo 500/230-kV transformer bank. These overloads are summarized below in Table 2-4 and Table 2-5 for Heavy Summer and Light Spring respectively. With the base case reduction in SES Solar One Project identified to mitigate thermal overload of the Lugo 500/230 kV transformer banks, a special protection system will be needed to mitigate thermal overloads under loss of one Lugo 500/230 kV transformer bank. Exact facilities needed to implement such a special protection system in order to allow temporary interconnection, subject to CAISO approval, of some amount of SES Solar One Project output should be derived as part of a separate study agreement.

Table 2-4
Heavy Summer Overloads with Pre-Project Upgrades
Under Loss of One Transmission Facility

Impacted Transmission Line	Worst Single Contingency	Pre	Post
Remaining Pisgah-Lugo 230 kV T/L	One Pisgah-Lugo 230 kV T/L	39%	186%
Remaining Lugo 500/230 kV Xfrm	One Lugo 500/230 kV Xfrm	166%	221%

Table 2-5
Light Spring Overloads with Pre-Project Upgrades
Under Loss of One Transmission Facility

Impacted Transmission Line	Worst Single Contingency	Pre	Post
Remaining Pisgah-Lugo 230 kV T/L	One Pisgah-Lugo 230 kV T/L	29%	172%
Remaining Lugo 500/230 kV Xfrm	One Lugo 500/230 kV Xfrm	183%	239%

Since the existing system cannot support the entire project output with all facilities in service, additional facility upgrades will be necessary. Consequently, the results under loss of one facility are presented in Table 3-1 and Table 3-2 and are for information purposes only.

<u>DOUBLE OUTAGE CONTINGENCY (N-2 or N-1 & T-1)</u>

The study identified that power flows do not converge under loss of both Lugo-Pisgah 230 kV or loss of both Pisgah-El Dorado 230 kV (one line ties into Cima). These study results are indicative of a potential voltage collapse. Since the existing system cannot support the entire project output with all facilities in service, the results under loss of two transmission lines were not closely examined for the existing system arrangement except for loss of two lines South of Lugo. Increases to base case South of Lugo flows results in conditions were the emergency thermal loading limit of the Lugo-Mira Loma 500 kV transmission lines are exceeded under loss of two of these lines.

C. Power Flow Study Results – Additional Upgrades Included in Base Case

The study results obtained from the power flow study with pre-project upgrades modeled to mitigate base case overload problems triggered by queued ahead projects are insufficient to accommodate the SES Solar One Project. As a result, facility upgrades triggered by the SES Solar One Project will be needed to interconnect and deliver the full output of the SES Solar One Project. The first set of facility upgrades evaluated includes a new 500 kV transmission line and an expansion of the Pisgah 230 kV substation to add a 500 kV switchrack with one 500/230 kV transformer bank connecting the 500 kV bus with the 230 kV bus. The new 500 kV transmission line was modeled as replacing an existing Lugo-Pisgah 230 kV transmission line. The final set of facility upgrades evaluated includes looping the existing Lugo-El Dorado 500 kV transmission line in and out of the new Pisgah 500 kV switchrack and adding a second 500/230 kV transformer bank at Pisgah. Both of these set of upgrades require opening the remaining Lugo-Pisgah 230 kV transmission line to eliminate thermal overload on this line. The following presents the power flow study results with the additional upgrades.

BASE CASE

With all pre-project upgrades and the first set of SES Solar One Project upgrades included into the study cases, the base case overloads identified on both Lugo-Pisgah 230 kV transmission lines and both Lugo 500/230 kV transformer banks are eliminated.

SINGLE OUTAGE CONTINGENCY (N-1 or T-1)

With the first set of facility upgrades modeled, the study identified two single outage contingencies that resulted in a case non-convergence problem. Loss of the new Lugo-Pisgah 500 kV transmission line or loss of the single Pisgah 500/230 kV transformer bank results in a possible voltage collapse problem. Under these two outage conditions, there is insufficient capacity to transfer the entire SES Solar One Project even if the voltage problem were resolved as the two remaining 230 kV lines in service from Pisgah can only carry approximately 575 MVA.

With the final set of facility upgrades modeled, no single outage contingency problems were identified.

DOUBLE OUTAGE CONTINGENCY (N-2 or N-1 & T-1)

The same south of Lugo double outage contingency identified without SES Solar One Project upgrades in place were identified in studies that modeled post-project upgrades.

D. Transient Stability Study Results

A number of transient stability problems were identified with the addition of the SES Solar One Project. These problems include the identification of no under-voltage ride-through capability when considering only the generation inertia constant (0.12 sec) as provided in Table 1-4 in the assumptions section. GE Energy also identified that the generation inertia constant for the generation machine resulted in unstable conditions following system faults. GE Energy recommended to SES that the inertia time constant for the prime mover be determined and added to the generator inertia constant provided. The GE Energy Report to Sterling Energy Systems, Inc. for PSLF Model for SES Solar is included for information in Appendix C. As of the publication date of this report, SES has not provided this information to SCE. SES engineers have been evaluating this potential LVRT issue with assistance from GE Power Systems Consulting Division. SES has informed SCE that it intends to provide SCE a more detailed dynamic model that better reflects the dynamic performance of the Solar Dish Systems.

Without the prime mover inertia constant, a bus fault at any of the locations examined resulted in sympathetic tripping of all of the 850 MW due to loss of synchronism. This finding is unacceptable and will require mitigation. In order to evaluate potential project impacts to the overall system if the project were to stay connected, parametric studies were performed. The methodology used systematically increased the inertia constant and generation MVA base until the project stayed connected after faulting the Pisgah 230 kV bus. Subsequent single and double line outage conditions were examined with this increased inertia constant and generation MVA base. Based on these sensitivity studies, it appears that the SES Solar One Project could adversely affect transient voltage performance. Voltage drops following standard fault clearing were found to exceed WECC Criteria and in some cases resulted in system instability. Since these results are based on sensitivity studies, it is imperative that additional transient stability studies be conducted as part of the Facilities Study with the more detailed dynamic model that will better reflect the dynamic performance of the Solar Dish Systems to be provided by SES. Transient stability plots for the analysis performed are provided in Appendix F.

E. <u>Short-Circuit Duty Study Results</u>

Historically, SCE has not conducted short-circuit duty studies were the generation project involved the use of induction machines. Recently, the CAISO has requested SCE to produce documentation that such machines do not contribute short-circuit duty under faulted conditions or perform such analysis. Short-circuit duty analysis for induction generation will be based on subsynchronous reactance provided and include the corresponding multiplication factor as identified in IEEE C.37.010.

Actual generation contributions to fault duty for induction generators depends on whether the induction generator maintains or losses its back electromagnetic field voltage. If the induction generator losses its field voltage, the induction generator would automatically disconnect and not provide any short-circuit contribution. Such a condition is unacceptable unless the outage effectively disconnect the generation facility from the SCE transmission systems, i.e. outage of the generation tie line connecting the project. SCE conducted the short-circuit duty study assuming the induction generators remain connected thus contribute to short-circuit duty. Three scenarios were examined to reflect short-circuit duty results without facility upgrades, and with initial and final facility upgrades as identified in the power flow study results section. The results of the maximum symmetrical three-phase-to-ground short circuit duty at the critical buses in the SCE bulk transmission system are summarized below in Table 2-6.

Without Facility Upgrades

The study results indicate that the SES Solar One Project increases short-circuit duties by an amount equal or greater than 0.1kA at eleven locations where duty is in excess of 60% of the minimum breaker nameplate rating. The following summarizes the impact of the SES Solar One Project:

- At Lugo 230kV substation bus, the short-circuit duty is increased by 1.1kA from 37.2 kA to 38.3 kA without facility upgrades. However, with the identified facility upgrades, duties at the Lugo 230 kV substation bus do not pass the screening level requirements. In other words, the facility upgrades result in increasing system impedance between the project and the Lugo 230 kV bus.

- At El Dorado 230kV substation bus, the short-circuit duty is increased by 0.5kA from 61.0 kA to 61.5 kA without facility upgrades, by 0.6 kA to 61.6 kA with the initial set of upgrades modeled and by 0.7 kA to 61.7 kA with the final set of upgrades modeled.

- At Lugo 500kV substation bus, the short-circuit duty is increased by 0.3kA from 45.2 kA to 45.5 kA without facility upgrades, by 1.2 kA to 46.4 kA with the initial set of upgrades modeled and by 1.5 kA to 46.7 kA with the final set of upgrades modeled.

- At El Dorado 500kV substation bus, the short-circuit duty is increased by 0.1kA from 41.9 kA to 42.0 kA without facility upgrades and with initial set of upgrades, and by 1.2 kA to 43.1 kA with the final set of upgrades modeled.

- With no facility upgrades modeled, breakers at the eleven locations were identified to require evaluation by SCE T/S Engineering to determine need for breaker replacement.

- With the initial set of upgrades modeled, breakers at the twenty-two locations were identified to require evaluation by SCE T/S Engineering to determine need for breaker replacement

- With the final set of upgrades modeled, breakers at the twenty-three locations were identified to require evaluation by SCE T/S Engineering to determine need for breaker replacement

Single-Phase-to-Ground short-circuit duty is dependant on tower design configuration which has not been provided for the radial gen-tie. As a result, SCE did not process single-phase-to-ground short-circuit duty analysis. SES should provide tower design for the gen-tie so that the single-phase-to-ground short-circuit duty analysis can be conducted as part of the Facilities Study.

Table 2-6
Three-Phase Short-Circuit Duty Study Results
Without and With Facility Upgrades Modeled

Substation	Bus Voltage	Pre		Post With No Upgrades			Post With Initial Upgrades			Post With Final Upgrades		
		X/R	KA	X/R	KA	D KA	X/R	KA	D KA	X/R	KA	D KA
El Dorado	500	19.9	41.9	19.9	42	0.1	19.9	42	0.1	20	43.1	1.2
Lugo	500	22.2	45.2	22.2	45.5	0.3	22.6	46.4	1.2	22.6	46.7	1.5
Mira Loma	500	24.6	34.8	24.6	34.9	0.1	24.8	35.1	0.3	24.8	35.2	0.4
Rancho Vista	500	28.8	26.8	Does Not Pass Screen			29	27	0.2	29	27	0.2
Serrano	500	25.4	31.3	Does Not Pass Screen			25.5	31.4	0.1	25.5	31.5	0.2
Vincent	500	17.7	34.9	17.7	35	0.1	17.8	35.1	0.2	17.8	35.1	0.2
Center	230	16	41.1	Does Not Pass Screen			16	41.2	0.1	16	41.2	0.1
Chino	230	16.9	49	Does Not Pass Screen			17	49.1	0.1	17	49.2	0.2
El Dorado	230	20.3	61	20.2	61.5	0.5	20.2	61.6	0.6	20.4	61.7	0.7
Etiwanda	230	26.1	59.2	26.1	59.3	0.1	26.2	59.5	0.3	26.2	59.5	0.3
Hinson	230	19.8	44.7	19.8	44.8	0.1	19.8	44.8	0.1	19.8	44.8	0.1
Jurupa	230	12.9	24.6	Does Not Pass Screen			12.9	24.7	0.1	12.9	24.7	0.1
Lighthipe	230	17.7	45.7	Does Not Pass Screen			17.7	45.8	0.1	17.7	45.8	0.1
Lugo	230	31.3	37.2	30.4	38.3	1.1	Does Not Pass Screen			Does Not Pass Screen		
Mira Loma East	230	23.1	62.5	23.1	62.6	0.1	23.2	62.8	0.3	23.2	62.9	0.4
Mira Loma West	230	19.9	50.9	Does Not Pass Screen			20	51.1	0.2	20	51.1	0.2
Pardee	230	17.5	55.4	Does Not Pass Screen			17.5	55.5	0.1	17.5	55.5	0.1
Pisgah	230	5.9	7.1	Does Not Pass Screen			Does Not Pass Screen			26.1	25.4	18.3
Rancho Vista	230	26.3	59.3	Does Not Pass Screen			26.4	59.5	0.2	26.5	59.6	0.3
Rio Hondo	230	17	40.6	17	40.7	0.1	17	40.7	0.1	17	40.7	0.1
Serrano	230	25.1	54.2	Does Not Pass Screen			25.2	54.3	0.1	25.2	54.3	0.1
Villa Park	230	22.2	47.2	Does Not Pass Screen			22.3	47.3	0.1	22.3	47.3	0.1
Victor	115	22.1	17.3	22	17.4	0.1	Does Not Pass Screen			Does Not Pass Screen		
Vincent	230	20.9	58.6	Does Not Pass Screen			20.9	58.7	0.1	20.9	58.7	0.1
Walnut	230	16.8	35.5	Does Not Pass Screen			16.8	35.6	0.1	16.8	35.6	0.1

F. Cost Estimates

Based on the study results, the SES Solar One Project triggers new overloads requiring mitigation measures. Since the current interconnection policy requires the project which triggers the need for an upgrade to be cost responsible, the amount of cost responsibility for the SES Solar One Project should be based on the actual system upgrade requirements needed to meet the operating date and those needed as the project increases its output as the SES Solar One Project is being developed over a period of 4 to 5 years.

Assuming that projects in queue ahead of the SES Solar One Project proceed forward, cost responsibility for the SES Solar One Project will be limited to the direct assigned facilities, Pisgah Substation expansion to 500 kV including transformation and new 230 kV positions, and a new SES Solar One Special Protection System required to mitigate overloads under outage conditions. Additional facilities, not identified in this study, may be needed to mitigate potential transient stability problems once follow-up transient stability studies are performed which utilize the updated dynamic model to be provided by SES within four to six week from publishing of this report. The preliminary cost estimates for the final integration plan are provided above in Table 2-7. These cost estimates are good-faith non-binding estimates subject to change based on detailed Facility Studies.

Table 2-7
Cost Estimates[1] Provided in Millions (2010 Dollars)

Facility Upgrade	Pre[2]	Post
New Kramer-Lugo 230 kV Transmission Line*	$72	
New Inyokern 230 kV Substation and Line Rearrangements*	$28	
Upgrades to Inyo Phase-Shift Transformer*	$6	
Expand Pisgah Substation: five 500 kV positions (three T/Ls and two transformers banks) and two new 230 kV positions		$160
Add new 500 kV line position at Lugo		$8
Remove one existing Lugo-Pisgah 230 kV T/L		$10
Construct New Lugo-Pisgah 500 kV T/L on existing ROW		$154
Loop Existing Lugo-El Dorado 500 kV T/L		$3
Open Remaining Lugo-Pisgah 230 kV T/L at Pisgah		No Cost
Telecommunications and Special Protection System		Unknown

Except for loading on the Lugo 500/230 kV transformer banks, the study identified minimal contribution to pre-project overloads without facility upgrades. Therefore, the SES Solar One Project should not be responsible for cost of additional transmission

[1] The *Nonbinding* Cost Estimate (Interconnection and Reliability Facilities) is $335,000,000 in 2010 dollars (the ITCC component associated with interconnection facilities will be collected via a Letter of Credit Purusant to FERC Order 2003A). Breakdown of the *Nonbinding* Cost Estimate will be provided as part of the Facilities Study.

[2] Cost estimates previously developed in support of conceptual studies performed for integrating Renewable Resources in the north of Lugo Area. The incremental loading on overloads triggering need for these upgrades do not rise to the level of significant and should therefore not result in potential cost assignment if projects in queue withdrew their interconnection request

upgrades if projects triggering the need for pre-project upgrades drop out of queue unless the project interconnects *initially* without construction of the 500 kV facilities. Such interconnection possibility should be examined as part of an Operational Study, if requested by SES Solar One, and will be subject to CAISO approval. Furthermore, additional facilities, not identified in this study, may be necessary to allow for such initial interconnection until the permanent mitigation is implemented. The exact nature and cost of facility upgrades associated with a temporary interconnection will be determined in the Operational Study, if requested.

G. Project Timelines

A significant amount of transmission facilities are necessary to mitigate pre-project base case, single outage, and double outage thermal overload problems which are aggravated with the addition of the project. These upgrades will require detailed environmental assessments sufficient to support filing for a Certificate of Public Convenience and Necessity (CPCN) at the California Public Utilities Commission (CPUC). As a result, the following project timelines are SCE's best judgment based on past permitting requirements and may be different depending on timelines associated with activities outside of SCE's control.

- Interconnection Studies: 12-18 months
- CPCN Application and Proponents Environmental Assessment (PEA): 12-18 months
- Review and Approval by CPUC: 12-18 months
- Project Development (right-of-way acquisition, material procurement and delivery, project construction): 24-30 months

These activities are sequential in nature and therefore the overall timeline requirements may range anywhere from 58 to 78 months to complete assuming all permitting activities are completed within the identified timeframes. Figure 3 provides the timelines assuming an aggressive schedule while Figure 4 provides the timelines assuming a less than aggressive schedule. The timelines are for information purposes only and will be revised to reflect appropriate scope of work as determined in the Facilities Study.

Figure 3
Aggressive Project Timeline

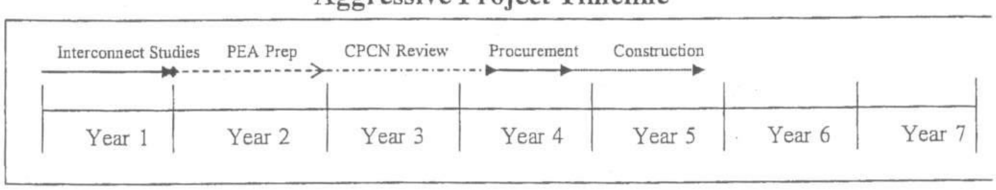
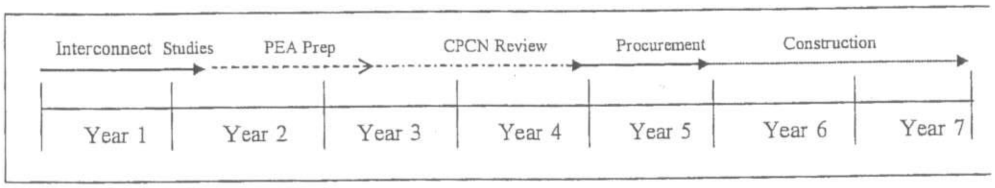


Figure 4
Less than Aggressive Project Timeline



IV. CONCLUSION

The north of Lugo transmission corridor does not have sufficient capacity to accommodate the SES Solar One Project without facility upgrades. In addition, the SES Solar One Project was found to increase South of Lugo transmission flows. Adding more generation north of Lugo or increasing imports from the north will further impact South of Lugo line flows. This study identified that approximately 50 MW of the project's 850 MW flows South of Lugo under generation redispatch patterns that minimize increases to South of Lugo. Different redispatch flow patterns will result in additional South of Lugo flows. Furthermore, generation located north of the SCE Lugo Substation is part of the Southern California Import Transmission (SCIT) flow. Consequently, the SES Solar One Project may be subjected to system limitations not identified in this report and be subject to dispatch with all other imports for transmission capacity according to the Southern California Import Transfer (SCIT) Nomogram.

POWER FACTOR CORRECTION

Based on load flow study results, SCE will require the SES Solar One Project to be able to provide reactive support corresponding to a 0.95 power factor boost.

LOAD FLOW RESULTS

The power flow studies identified that base case overloads, with all facilities in service, triggered by projects in queue ahead of the SES Solar One Project were not significantly aggravated by the SES Solar One Project. However, the study identified that the SES Solar One Project triggers new base case overload problems on the two existing Lugo-Pisgah 230 kV transmission lines and two Lugo 500/230-kV transformer banks. In addition to the base case overloads, the studies identified numerous single contingencies that result in severe thermal overload problems some which are aggravated by the SES Solar One Project. It's worth noting that the two Lugo-Pisgah 230 kV transmission lines do not have any emergency capability due to line clearance. As a result, the use of a Special Protection System to mitigate thermal overloads on these two transmission lines is not recommended since a large number of facilities, beyond SCE's design limitation, would need to be monitored and implemented into the special protection system logic processor. Facilities upgrades will therefore be needed to mitigate these overload problems.

With upgrades modeled into the base case, the study identified that all impacts associated with the inclusion of the SES Solar One Project were mitigated except for loss of two 500 kV lines

South of Lugo. Under such outage conditions, the South of Lugo flows were found to exceed the maximum south of Lugo capability.

BASE CASE CONGESTION MANAGEMENT

For reasons discussed above, SCE does not recommend implementation of congestion management protocols as a mitigation option to manage flows on the two existing Lugo-Pisgah 230 kV transmission lines. Since the SES Solar One Project is being phased in over four to five years beginning in 2009 and SCE has identified a transmission project (Vincent to Mira Loma 500 kV transmission line) which will increase the total deliveries from the north into Mira Loma, SCE recommends the use of congestion management to limit south of Lugo flows to within limits (5600 MW post Mira Loma Loop). If for some reason, the Vincent to Mira Loma 500 kV transmission line project is terminated, additional congestion management not identified in this study may be needed.

TRANSIENT STABILITY RESULTS

A number of transient stability problems were identified with the addition of the SES Solar One Project. The most critical problem includes the identification of no low-voltage ride-through (LVRT) capability with use of the generation model provided in Table 1-4 in the assumptions section. This problem impinges on the operator's ability to properly operate the transmission system. The study identified generation disruptions on numerous faults located throughout the Western United States. Sensitivity studies performed with larger inertia constants in order to maintain generators connected identified WECC voltage criteria violations and system instability problems. Engineers at SES have been evaluating the potential LVRT issue with assistance from GE Power Systems Consulting Division. SES has informed SCE that it is in the process of developing a more detailed dynamic model that better reflects the dynamic performance of the Solar Dish Systems. SES will be required to provide SCE with the updated dynamic model upon completion in order to re-examine transient stability system performance prior to finalizing Facilities Study.

SHORT-CIRCUIT DUTY RESULTS

Studies assuming the Solar Dish Systems remained connected identified eleven substation locations where the duty was increased by more than 0.1 kA and duty exceeded 60% of the minimum breaker nameplate rating, without facility upgrades modeled. The number of substation locations where the duty was increased by more than 0.1 kA and duty exceeded 60% of the minimum breaker nameplate rating increased to twenty-two and twenty-three with the initial set of upgrades and final set of upgrades modeled respectively. SCE recommends that the more detailed dynamic model representation under development by SES also include a more detailed short-circuit duty model which would better reflect short-circuit duty contributions from the project. As part of the Facilities Study, SCE will evaluate the substation locations identified in this study to determine need for upgrade or breaker replacement. A restudy for short-circuit duty and reevaluation of any identified substation locations will be needed once the new model is made available.

SPECIAL PROTECTION SYSTEM REQUIREMENT

With the initial set of facility upgrades modeled, a special protection system will be required to trip the project under two different outage conditions. Tripping is not recommended for loss of two south of Lugo 500 kV transmission facilities as loading on these facilities should be managed under base case conditions, as recommended above. With the final upgrades modeled, the need for a special protection system is reduced to one outage condition. The outages requiring need for a special protection system are summarized below in Table 2-8.

Table 2-8
Outages Requiring Special Protection System

Transmission Facility Outage	Initial Upgrades	Final Upgrades
Lugo-Pisgah 500 kV Transmission Line (N-1)	SPS	No SPS
Pisgah 500/230 kV Transformer Bank (T-1)	SPS	No SPS
Lugo-Pisgah 500-kV Transmission Lines (N-2)	Doesn't Exist	SPS

OPERATIONAL STUDY REQUIREMENTS

The SES Solar One Project has indicated a desire to interconnect and expand their project over a period of five years. Initially, they would like to interconnect prior to the in-service date of the final facility upgrades. As a result, an Operational Study will be necessary to examine the need for facility upgrades to interconnect the SES Solar One Project and those projects with an in-service date up to the same year as the SES Solar One Project. Any facility upgrades identified to be needed under this interconnection ordering sequence will be required prior to allowing interconnection of the SES Solar One Project. Additional facilities, not identified in this study, may be necessary to allow for such initial interconnection. Schedule and cost of such facilities, to be identified in an Operational Study if requested by SES, is not identified in this System Impact Study report. This information will be provided as part of the Operational Study, if requested.

FACILITY STUDY

A Facility Study will be required to determine the facilities and upgrades necessary to interconnect the proposed SES Solar One Project. The study should:

1. Perform additional transient stability studies with an updated dynamic model to be provided by SES. It is anticipated that SES will provide such model to SCE within four to six weeks from publishing of this report. SCE will provide transient study results with the updated model to the CAISO upon completion.

2. Investigate feasibility and develop cost associated with removing one existing Lugo-Pisgah 230 kV transmission line and replacing with a new Lugo-Pisgah 500 kV transmission line. The remaining Lugo-Pisgah 230 kV transmission line is to be idled (left in place for future use).

3. Investigate feasibility and develop cost associated with looping the existing Lugo-El Dorado 500 kV transmission line in and out of a new Pisgah 500 kV substation.

4. Develop cost associated with expanding and converting the existing Pisgah 230 kV substation to a 500 kV substation. The substation design should include:

   - a new 500 kV switchrack
   - two 500/230 kV transformer banks
   - three 500 kV transmission line positions with a design to allow for a fourth line
   - equipping positions 3 and 6 with breakers to allow for transformer bank connections
   - expansion of 230 kV switchrack to allow termination of new SES Solar One Gen-Tie

5. Review circuit breakers at the twenty-three locations identified to determine need for breaker replacement and develop cost estimates. A restudy for short-circuit and reevaluation will be needed once the new model is made available. SCE will provide revised short-circuit duty results with the updated model to the CAISO upon completion.

6. Develop and provide cost for appropriate special protection system.

TABLES

Table 3-1
Heavy Summer Power Flow Study Results
SES Solar 1 Project at 850 MW

Outage Case	Outage Type	Transmission Outage	Overloaded Transmission Facilities	Rating (Note 1) Normal	Rating (Note 1) Emerg	Pre-Project Loading (Note 2)	Pre-Project Normal	Pre-Project Emerg	Post-Project Loading (Note 2)	Post-Project Normal	Post-Project Emerg	Project Impact Amps	Project Impact Percent
1000	N-0	Base Case	Lugo-Pisgah No. 1 230 kV	725	725	184	25.3%		880	121.3%		696	96.0%
			Lugo-Pisgah No. 2 230 kV	725	725	182	25.1%		875	120.6%		692	95.4%
			Lugo No. 2 500/230 kV	1120	1230	975	87.0%		1283	114.6%		308	27.5%
			Lugo No. 1 500/230 kV	1120	1230	968	86.4%		1274	113.8%		306	27.4%
1001	Single	El Dorado-Lugo 500 kV	Lugo-Pisgah No. 1 230 kV	725	725	240	33.1%	33.1%	949	130.9%	130.9%	709	97.8%
			Lugo-Pisgah No. 2 230 kV	725	725	239	32.9%	32.9%	944	130.1%	130.1%	705	97.2%
1002	Single	El Dorado-Mohave 500 kV	Lugo-Pisgah No. 1 230 kV	725	725	215	29.6%	29.6%	924	127.4%	127.4%	709	97.7%
			Lugo-Pisgah No. 2 230 kV	725	725	214	29.5%	29.5%	918	126.6%	126.6%	705	97.1%
1003	Single	Lugo-Mohave 500 kV	Lugo-Pisgah No. 1 230 kV	725	725	215	29.6%	29.6%	920	126.8%	126.8%	705	97.2%
			Lugo-Pisgah No. 2 230 kV	725	725	214	29.5%	29.5%	915	126.1%	126.1%	701	96.6%
1004	Single	Lugo-Victorville 500 kV	Lugo-Pisgah No. 1 230 kV	725	725	318	43.9%	43.9%	1023	141.0%	141.0%	704	97.1%
			Lugo-Pisgah No. 2 230 kV	725	725	317	43.6%	43.6%	1017	140.1%	140.1%	700	96.5%
1005	Single	Devers-Palo Verde 500 kV	Lugo-Pisgah No. 1 230 kV	725	725	209	28.8%	28.8%	920	126.8%	126.8%	711	98.1%
			Lugo-Pisgah No. 2 230 kV	725	725	207	28.6%	28.6%	915	126.1%	126.1%	707	97.5%
1007	Single	El Dorado-Pisgah-Cima No. 1 230 kV	Lugo-Pisgah No. 1 230 kV	725	725	117	16.2%	16.2%	1028	141.7%	141.7%	911	125.5%
			Lugo-Pisgah No. 2 230 kV	725	725	117	16.1%	16.1%	1022	140.9%	140.9%	905	124.8%
1008	Single	El Dorado-Pisgah No. 2 230 kV	Lugo-Pisgah No. 1 230 kV	725	725	117	16.1%	16.1%	1026	141.5%	141.5%	909	125.4%
			Lugo-Pisgah No. 2 230 kV	725	725	116	16.0%	16.0%	1020	140.7%	140.7%	904	124.6%
1011	Single	Lugo-Pisgah No. 1 230 kV				System Within Limits			Diverged			Potential Voltage Collapse	
1012	Single	Lugo-Pisgah No. 2 230 kV				System Within Limits			Diverged				
1015	Single	Lugo No. 1 500/230 kV	Lugo No.2 500/230 kV	1120	1230	1863	166.4%	151.5%	2477	221.2%	201.4%	614	54.8%
1016	Single	Lugo No. 2 500/230 kV	Lugo No.1 500/230 kV	1120	1230	1862	166.3%	151.4%	2477	221.2%	201.4%	614	54.9%
2002	Double	Lugo-Mira Loma No. 1 500 kV	Lugo-Mira Loma No. 3 500 kV	3950	5330	5298	134.1%	99.4%	5439	137.7%	102.0%	141	3.6%
		Lugo-Mira Loma No. 2 500 kV											
2002	Double	Lugo-Mira Loma No. 2 500 kV	Lugo-Mira Loma No. 1 500 kV	3950	5330	5205	131.8%	97.7%	5343	135.3%	100.3%	139	3.5%
		Lugo-Mira Loma No. 3 500 kV											
2002	Double	Lugo-Mira Loma No. 1 500 kV	Lugo-Mira Loma No. 2 500 kV	3950	5330	5332	135.0%	100.0%	5477	138.7%	102.8%	146	3.7%
		Lugo-Mira Loma No. 3 500 kV											

Note 1 - The ratings for transmission lines and transformers are given Amperes and MVA, respectively.
Note 2 - The loading on transmission lines and transformers are given Amperes and MVA, respectively.

Table 3-2
Light Spring Power Flow Study Results
SES Solar 1 Project at 850 MW

Outage Case	Outage Type	Transmission Outage	Overloaded Transmission Facilities	Rating (Note 1)		Pre-Project			Post-Project			Project Impact	
				Normal	Emerg	Loading (Note 2)	Normal	Emerg	Loading (Note 2)	Normal	Emerg	Amps	Percent
1000	N-0	Base Case	Lugo-Pisgah No. 1 230 kV	725	725	138	19.0%		826	113.9%		688	94.9%
			Lugo-Pisgah No. 2 230 kV	725	725	137	18.9%		821	113.2%		684	94.3%
			Lugo No. 2 500/230 kV	1120	1230	1072	95.7%		1328	118.5%		256	22.9%
			Lugo No. 1 500/230 kV	1120	1230	1064	95.0%		1318	117.7%		254	22.7%
1001	Single	El Dorado-Lugo 500 kV	Lugo-Pisgah No. 1 230 kV	725	725	193	26.6%	26.6%	899	123.9%	123.9%	706	97.4%
			Lugo-Pisgah No. 2 230 kV	725	725	192	26.4%	26.4%	894	123.2%	123.2%	702	96.8%
1002	Single	El Dorado-Mohave 500 kV	Lugo-Pisgah No. 1 230 kV	725	725	169	23.3%	23.3%	868	119.7%	119.7%	699	96.4%
			Lugo-Pisgah No. 2 230 kV	725	725	168	23.1%	23.1%	863	119.0%	119.0%	695	95.8%
1003	Single	Lugo-Mohave 500 kV	Lugo-Pisgah No. 1 230 kV	725	725	169	23.3%	23.3%	869	119.8%	119.8%	700	96.5%
			Lugo-Pisgah No. 2 230 kV	725	725	168	23.1%	23.1%	864	119.1%	119.1%	696	95.9%
1004	Single	Lugo-Victorville 500 kV	Lugo-Pisgah No. 1 230 kV	725	725	245	33.8%	33.8%	955	131.6%	131.6%	710	97.8%
			Lugo-Pisgah No. 2 230 kV	725	725	243	33.6%	33.6%	949	130.8%	130.8%	705	97.2%
1005	Single	Devers-Palo Verde 500 kV	Lugo-Pisgah No. 1 230 kV	725	725	160	22.1%	22.1%	861	118.7%	118.7%	701	96.6%
			Lugo-Pisgah No. 2 230 kV	725	725	159	22.0%	22.0%	856	118.0%	118.0%	697	96.1%
1007	Single	El Dorado-Pisgah-Cima No. 1 230 kV	Lugo-Pisgah No. 1 230 kV	725	725	88	12.1%	12.1%	985	135.7%	135.7%	897	123.6%
			Lugo-Pisgah No. 2 230 kV	725	725	87	12.0%	12.0%	979	134.9%	134.9%	891	122.9%
1008	Single	El Dorado-Pisgah No. 2 230 kV	Lugo-Pisgah No. 1 230 kV	725	725	88	12.1%	12.1%	983	135.5%	135.5%	895	123.4%
			Lugo-Pisgah No. 2 230 kV	725	725	87	12.0%	12.0%	977	134.7%	134.7%	890	122.6%
1011	Single	Lugo-Pisgah No. 1 230 kV				System Within Limits			Diverged			Potential Voltage Collapse	
1012	Single	Lugo-Pisgah No. 2 230 kV				System Within Limits			Diverged				
1015	Single	Lugo No. 1 500/230 kV	Lugo No. 2 500/230 kV	1120	1230	2046	182.7%	166.3%	2676	238.9%	217.6%	630	56.3%
1016	Single	Lugo No. 2 500/230 kV	Lugo No. 1 500/230 kV	1120	1230	2045	182.6%	166.2%	2676	238.9%	217.6%	631	56.4%

Note 1 - The ratings for transmission lines and transformers are given Amperes and MVA, respectively.
Note 2 - The loading on transmission lines and transformers are given Amperes and MVA, respectively.

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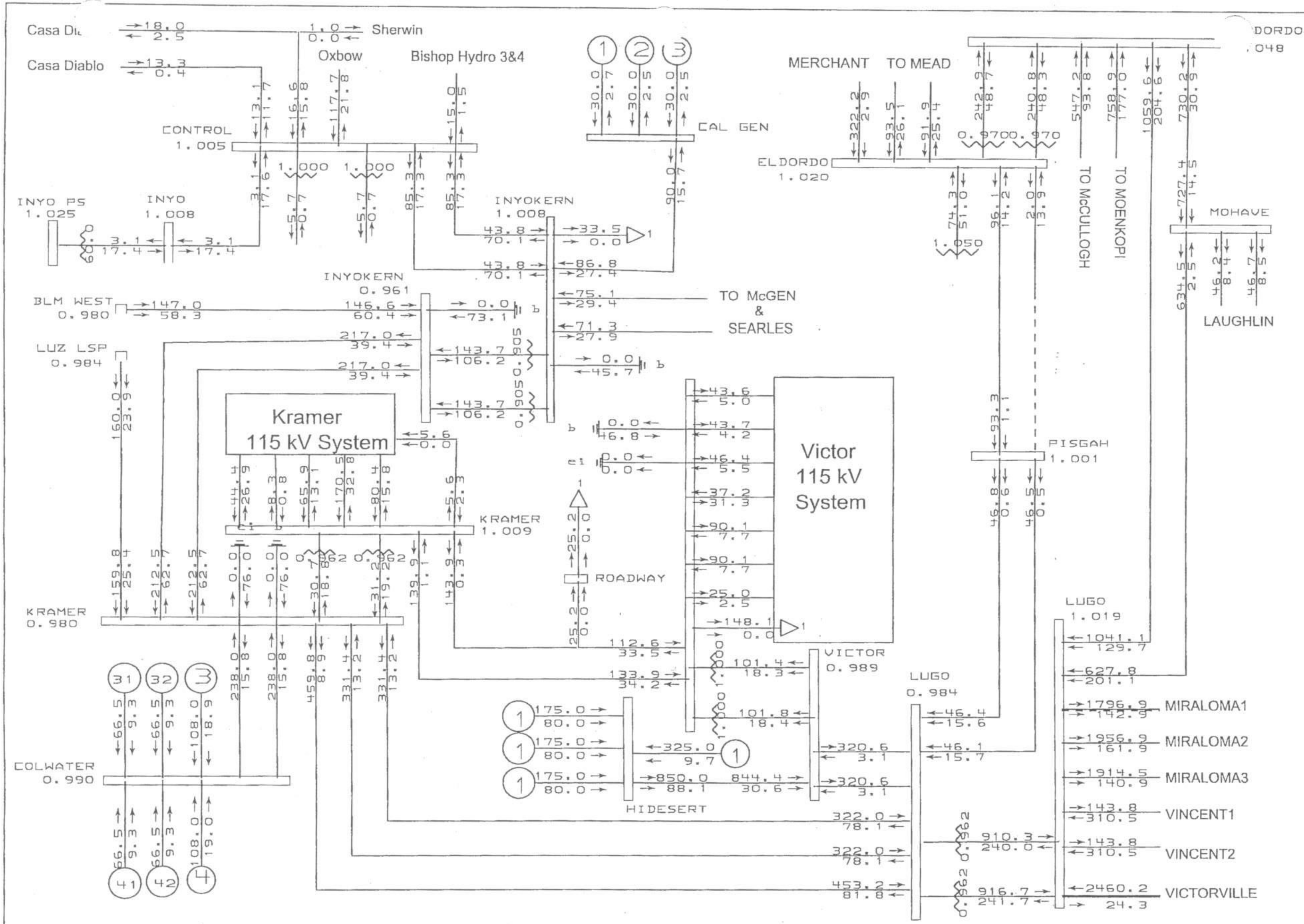
APPENDIX A

HEAVY SUMMER
POWER FLOW PLOTS



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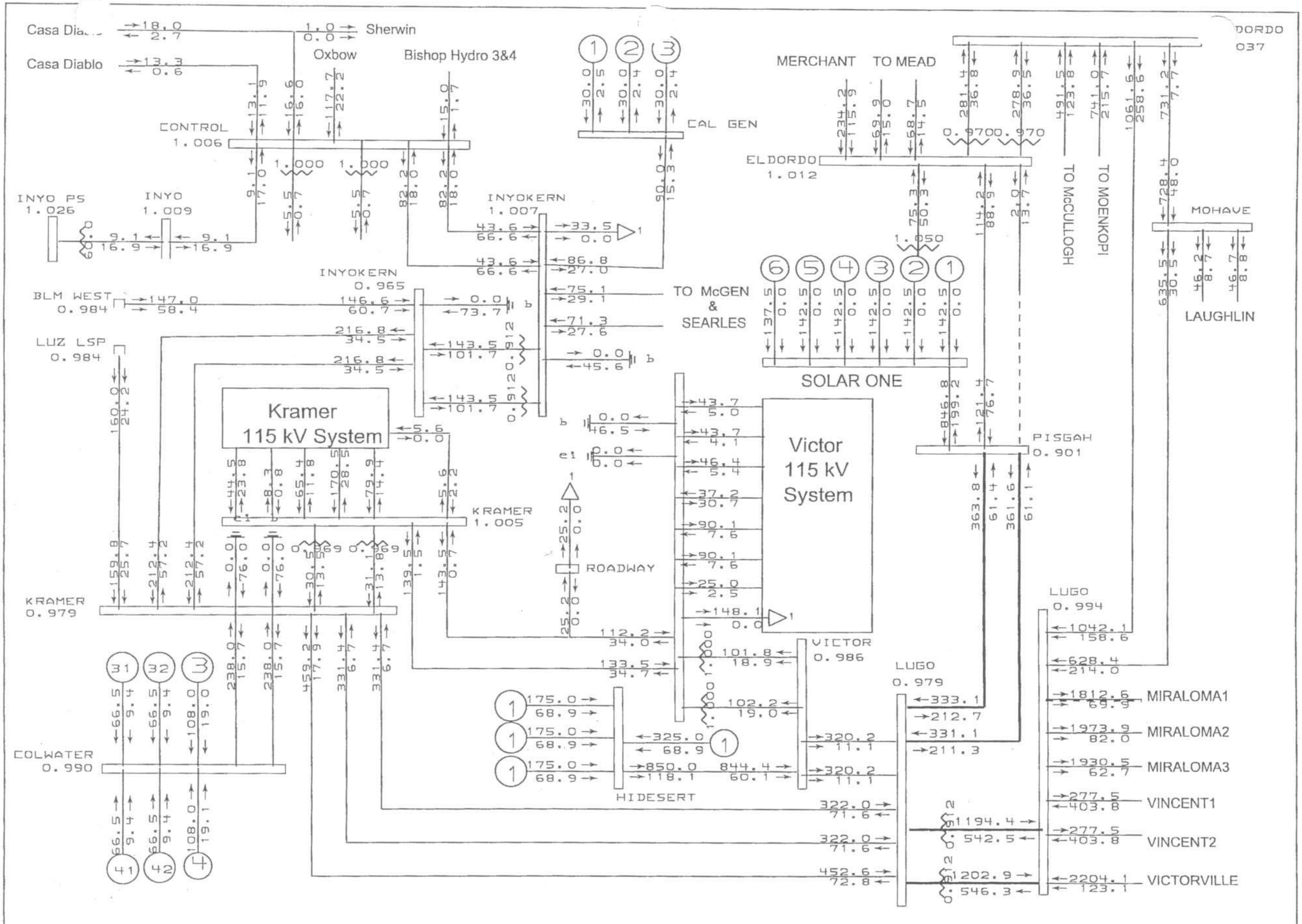

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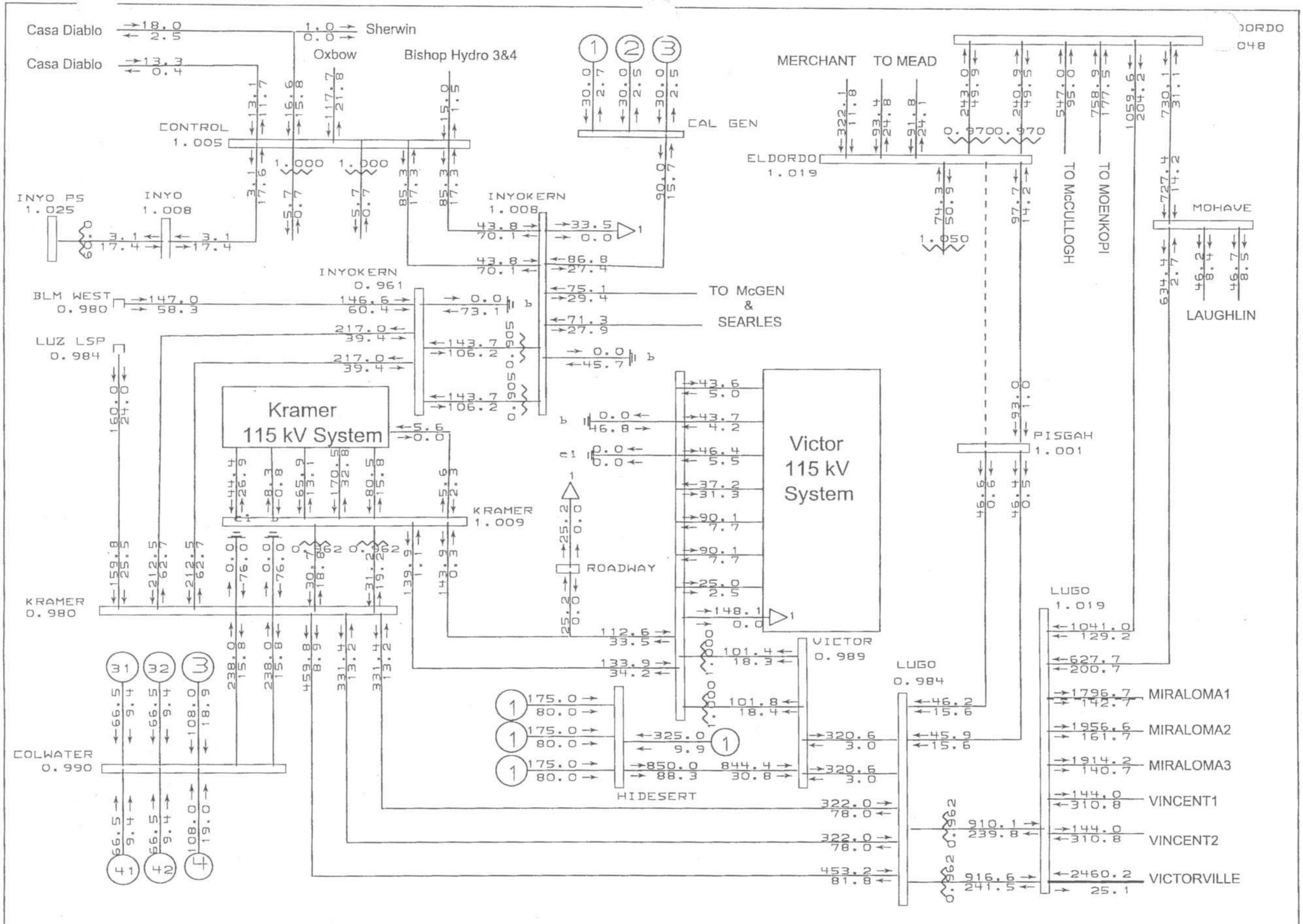

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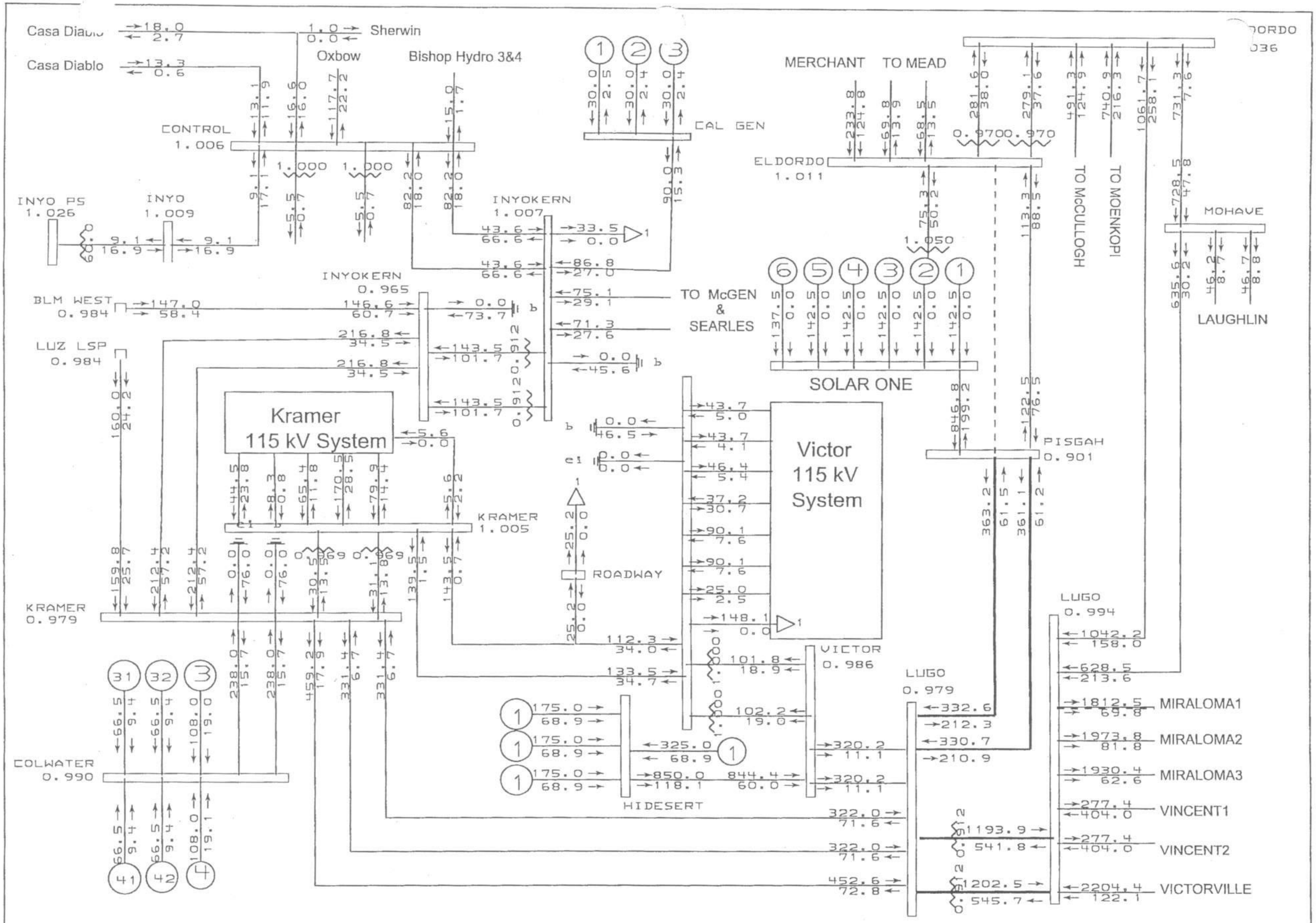

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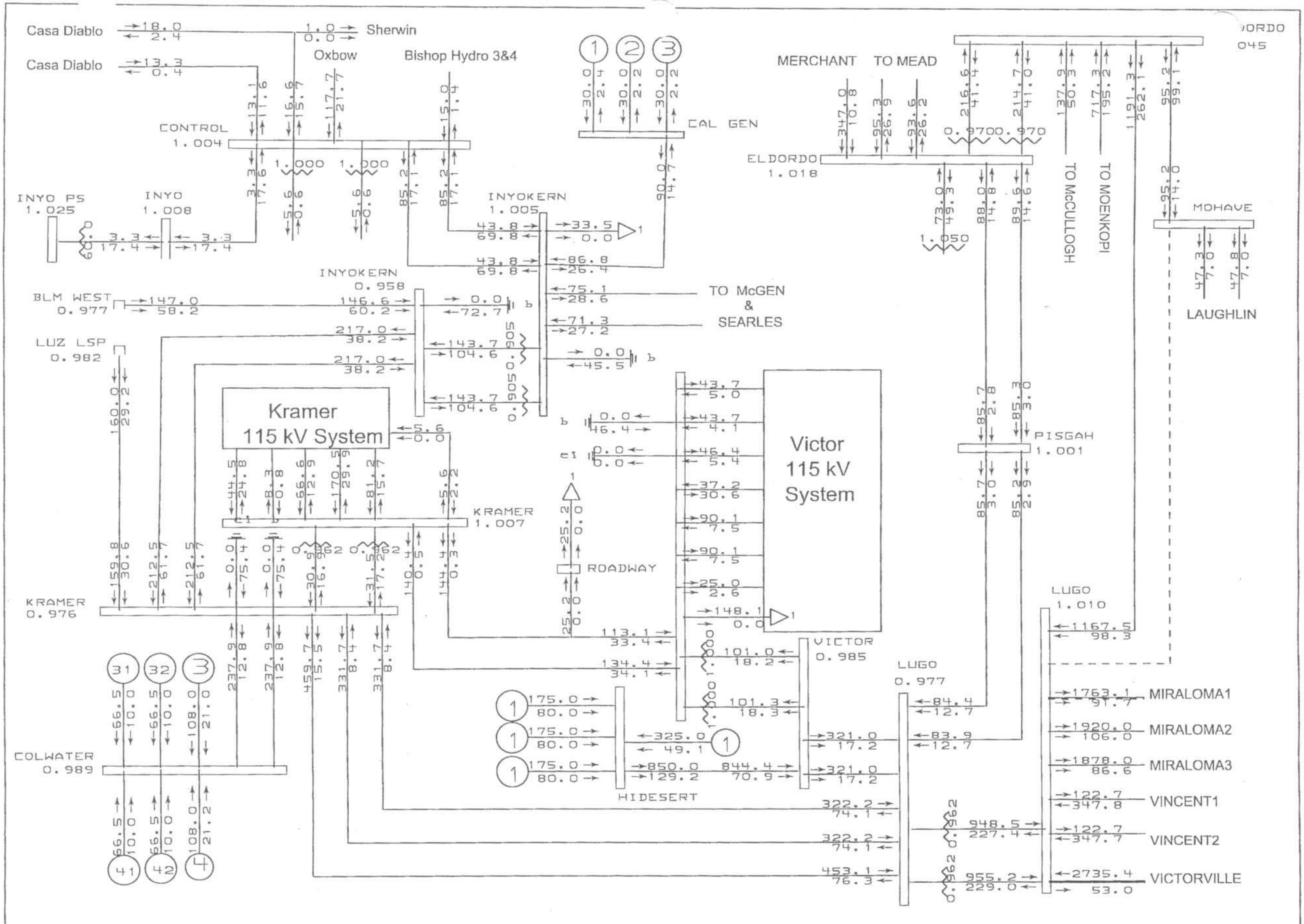

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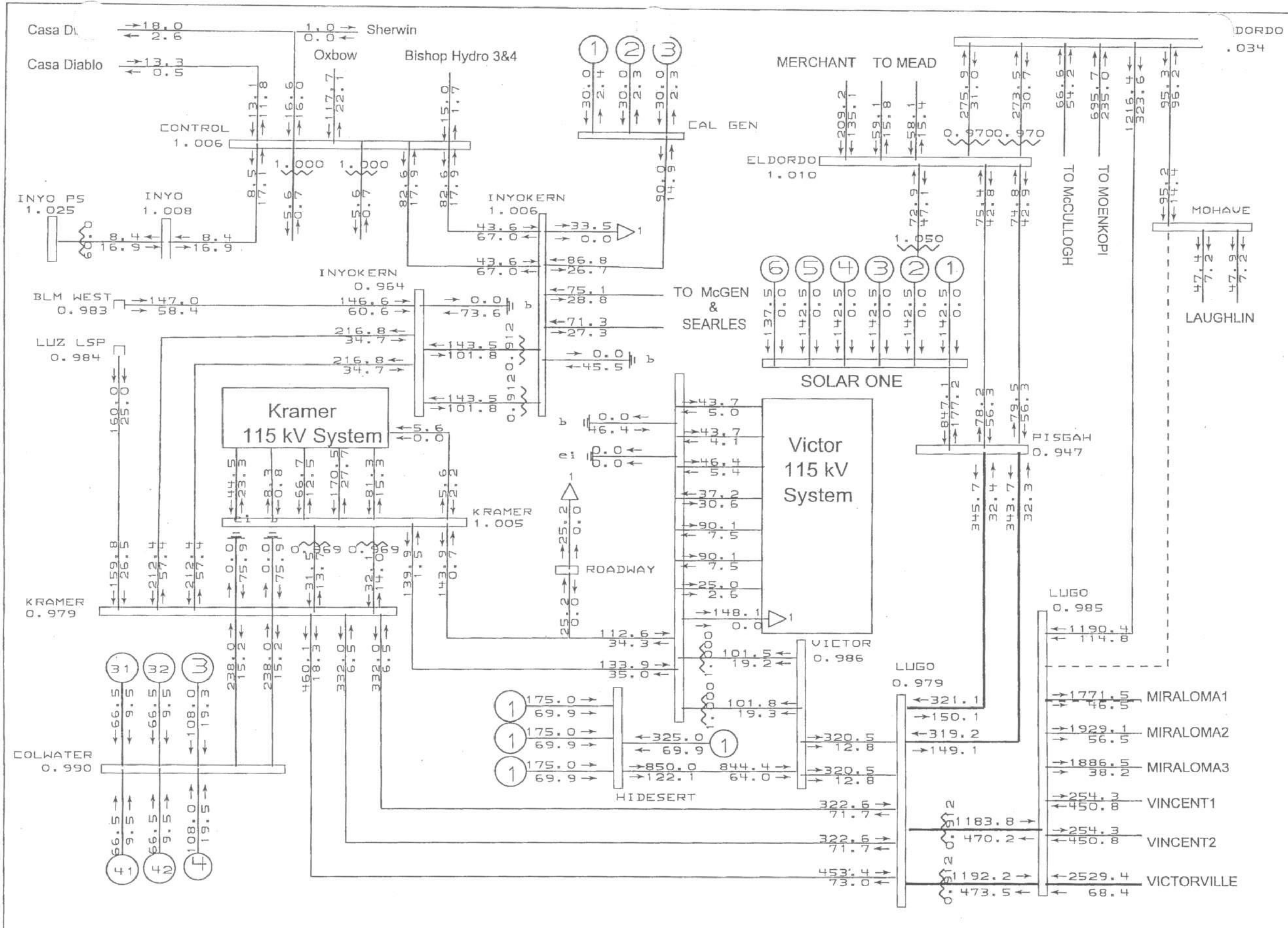

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Solar I System Impact Study: Post-Project
2009 Heavy Summer Load Conditions
Power Flow Case with SES Plant at 850 MW

N-1: Lugo-Mohave 500 kV Line

PSLF Program
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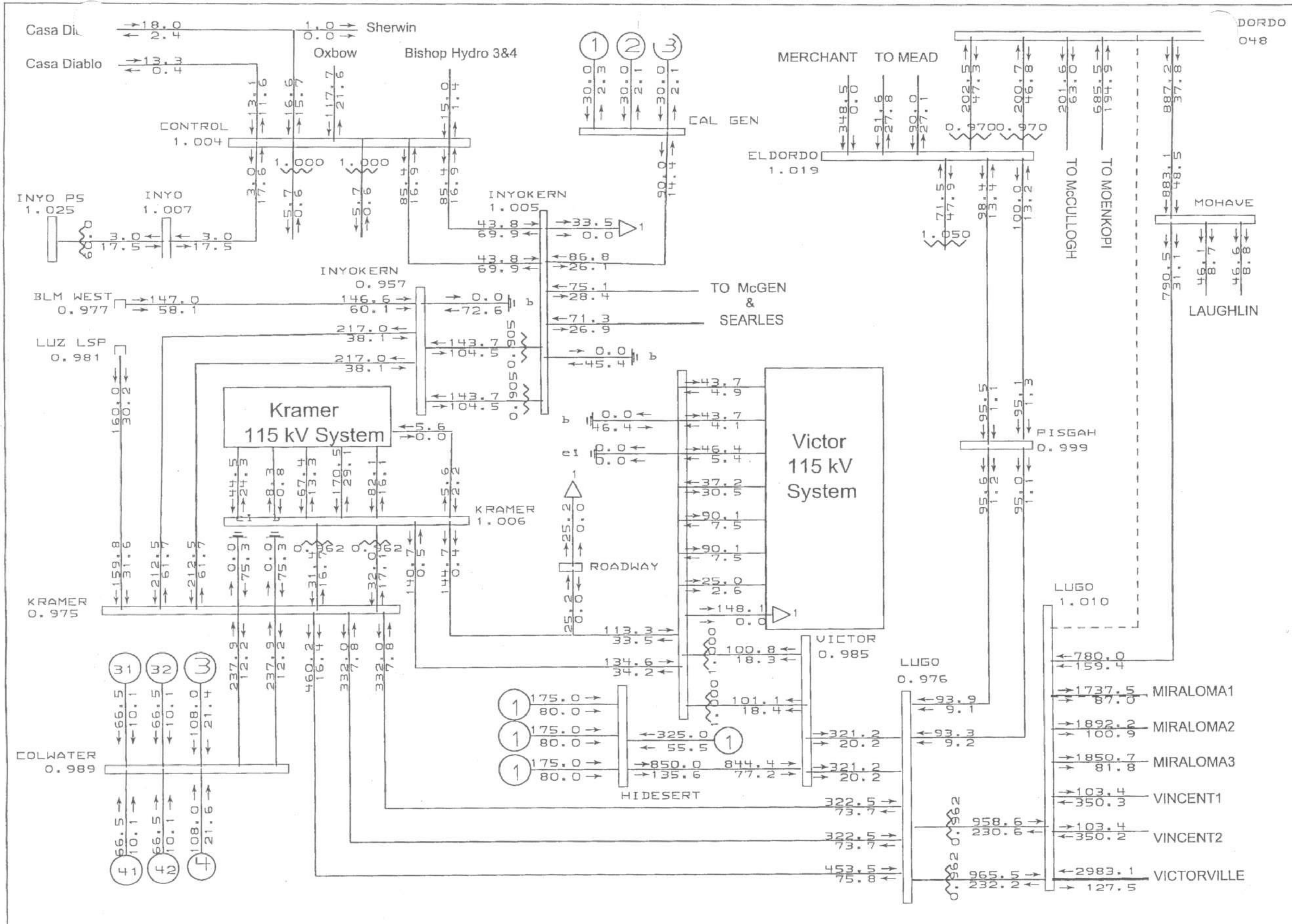

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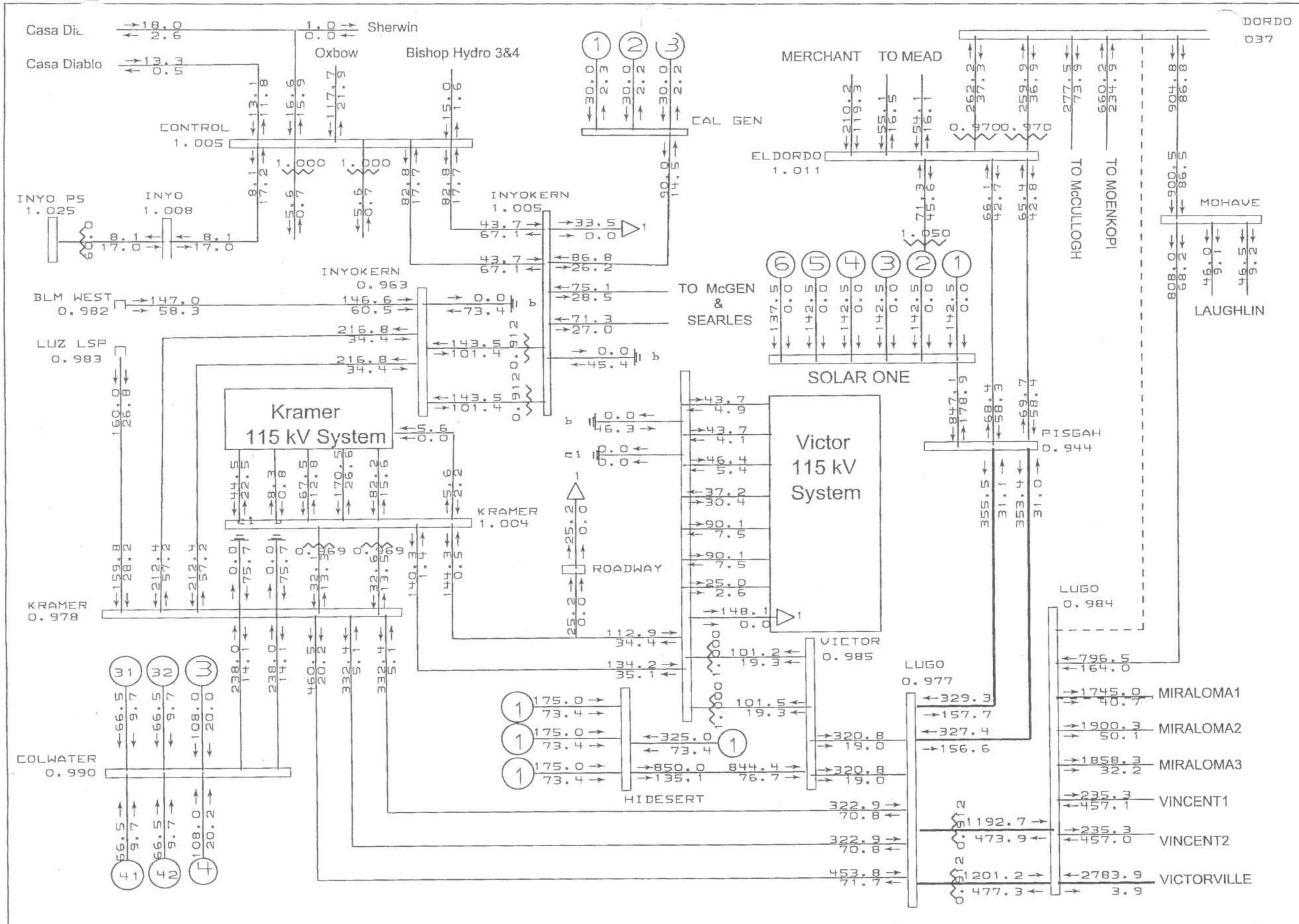

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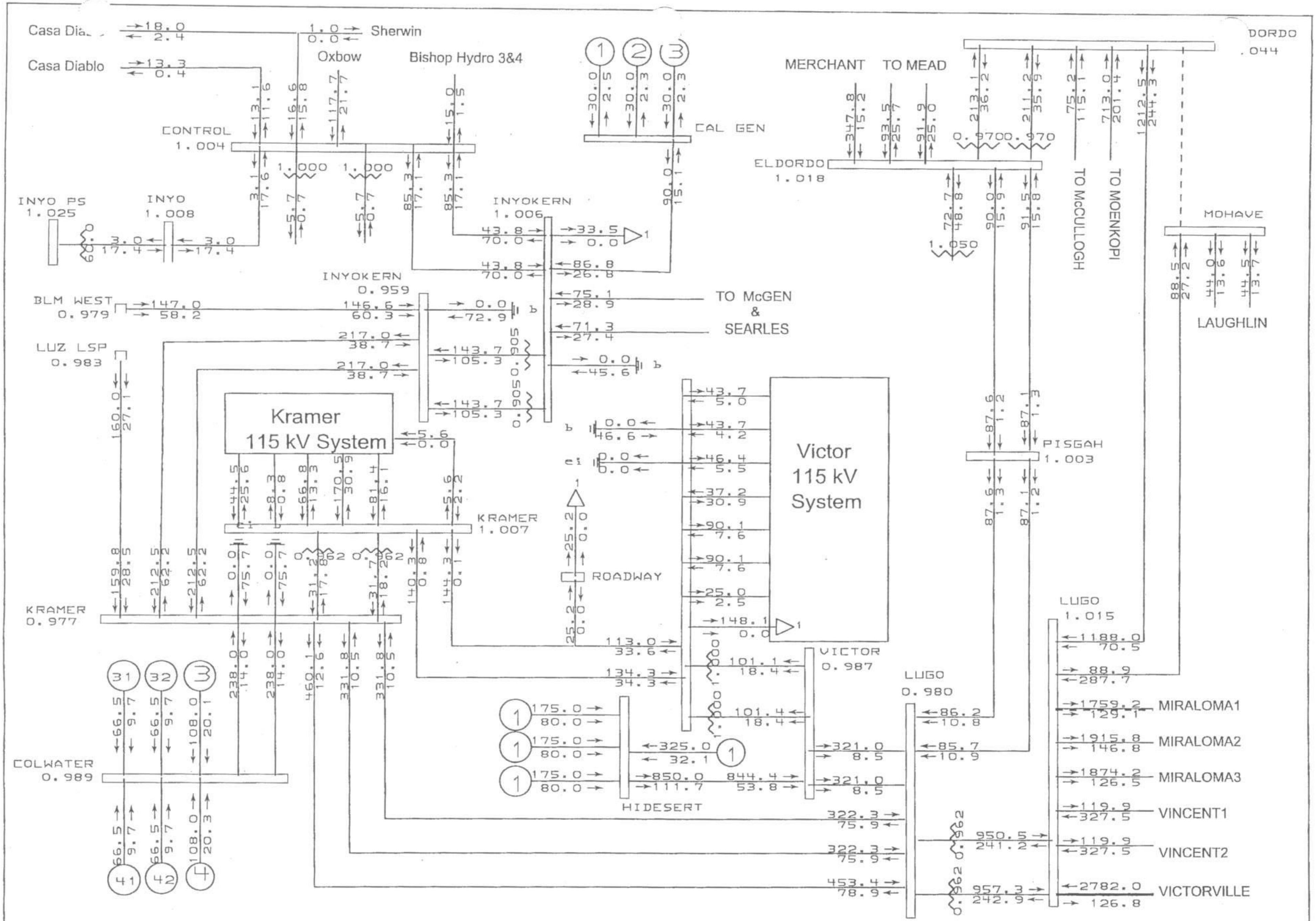

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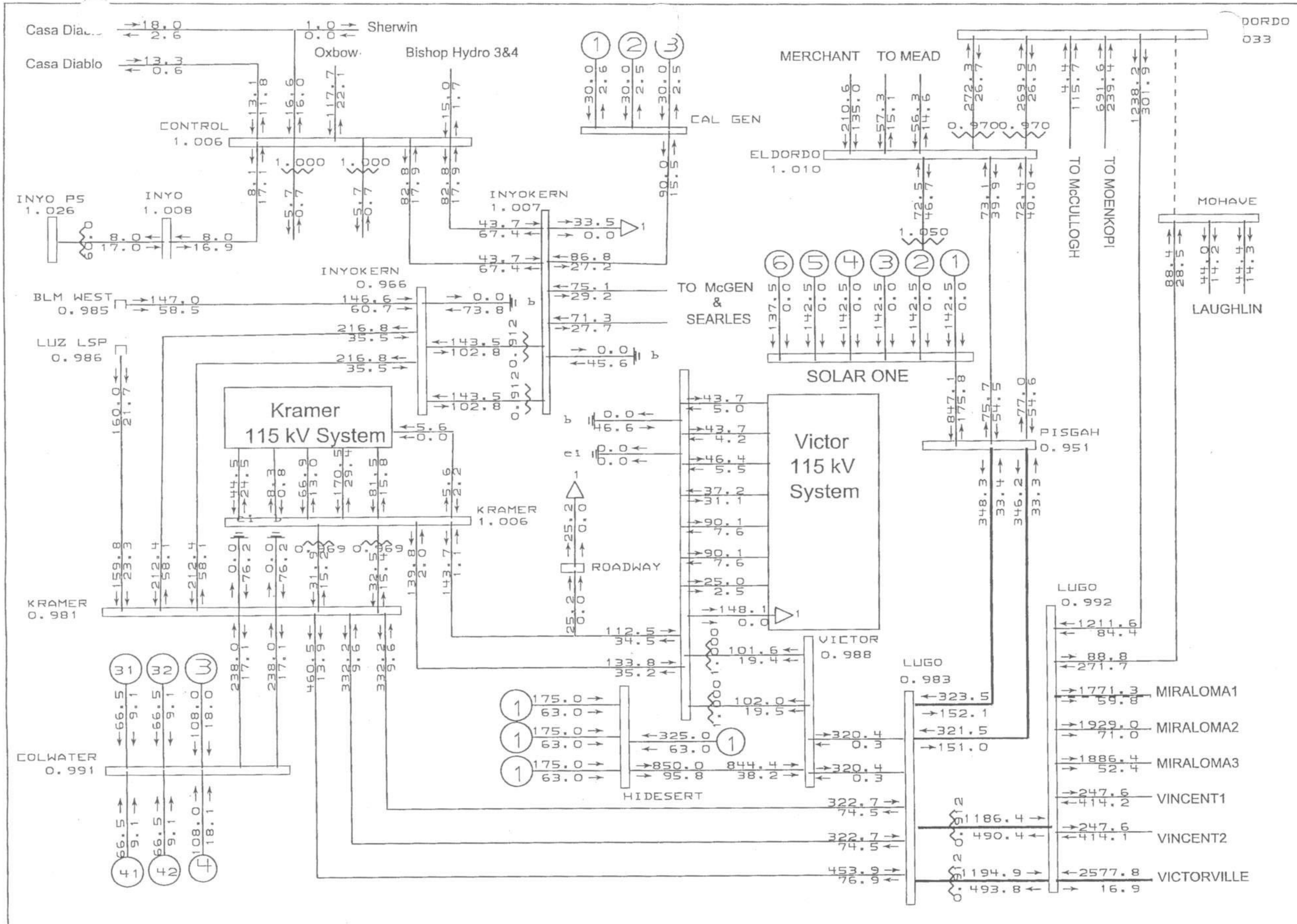

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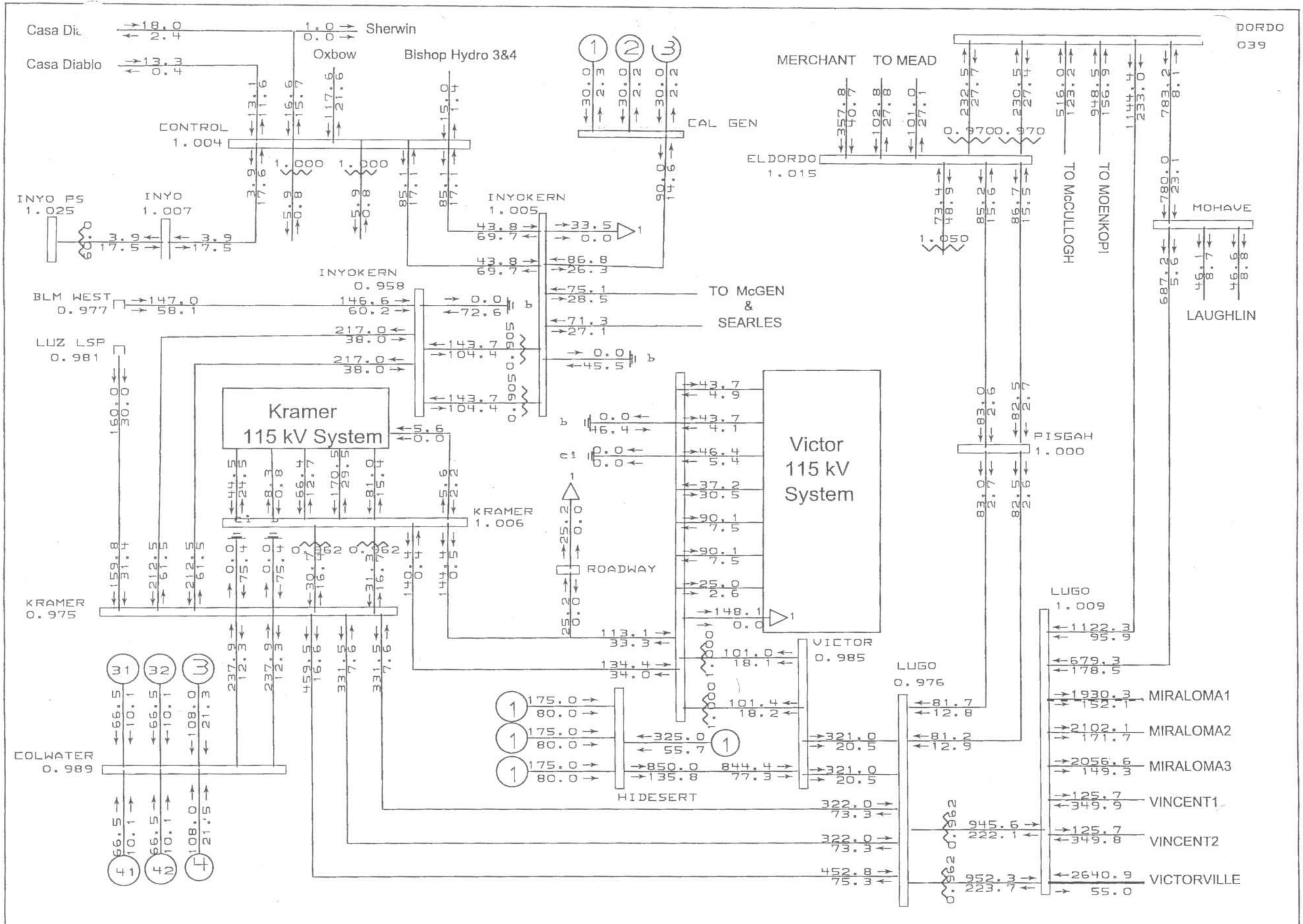

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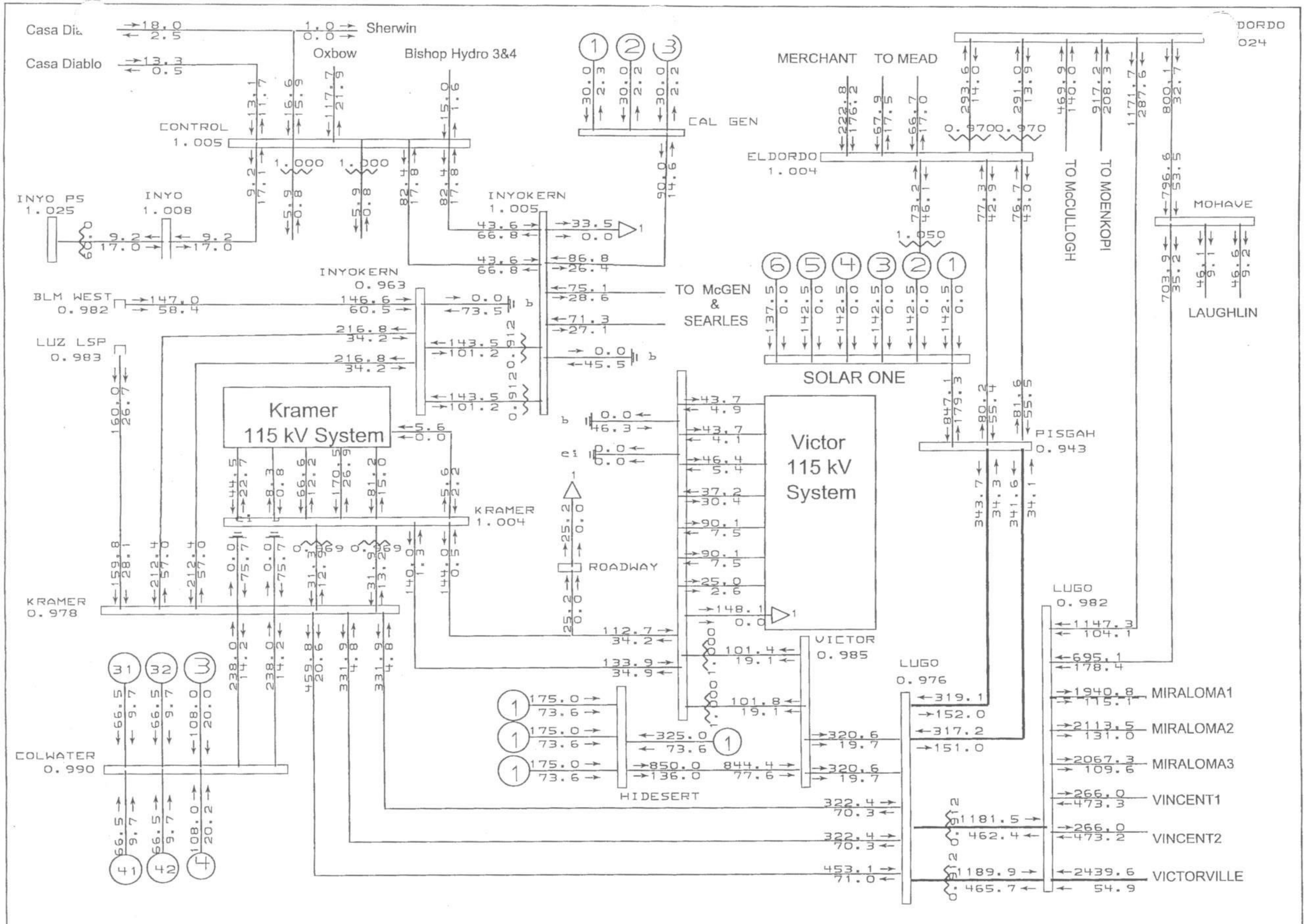

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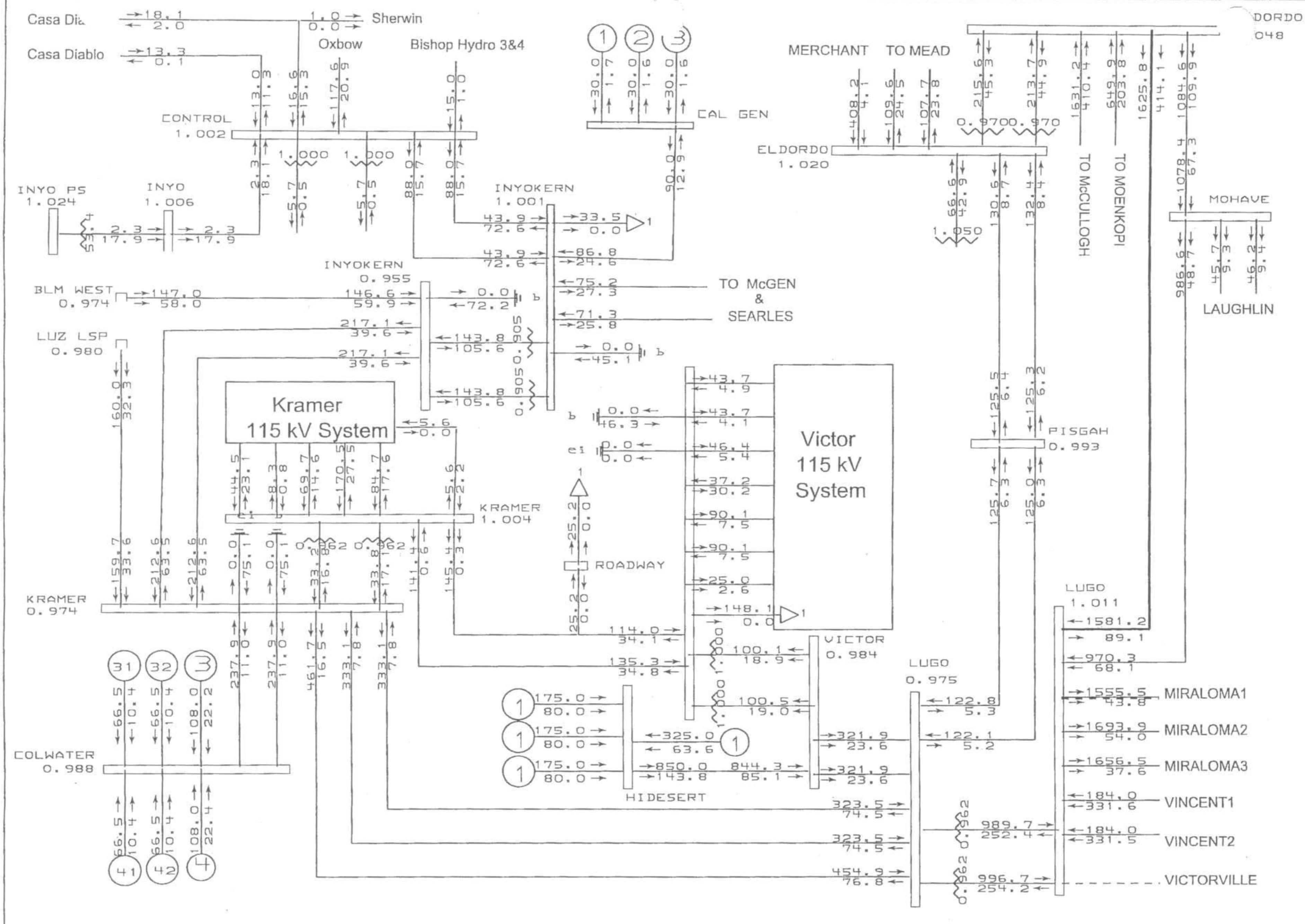

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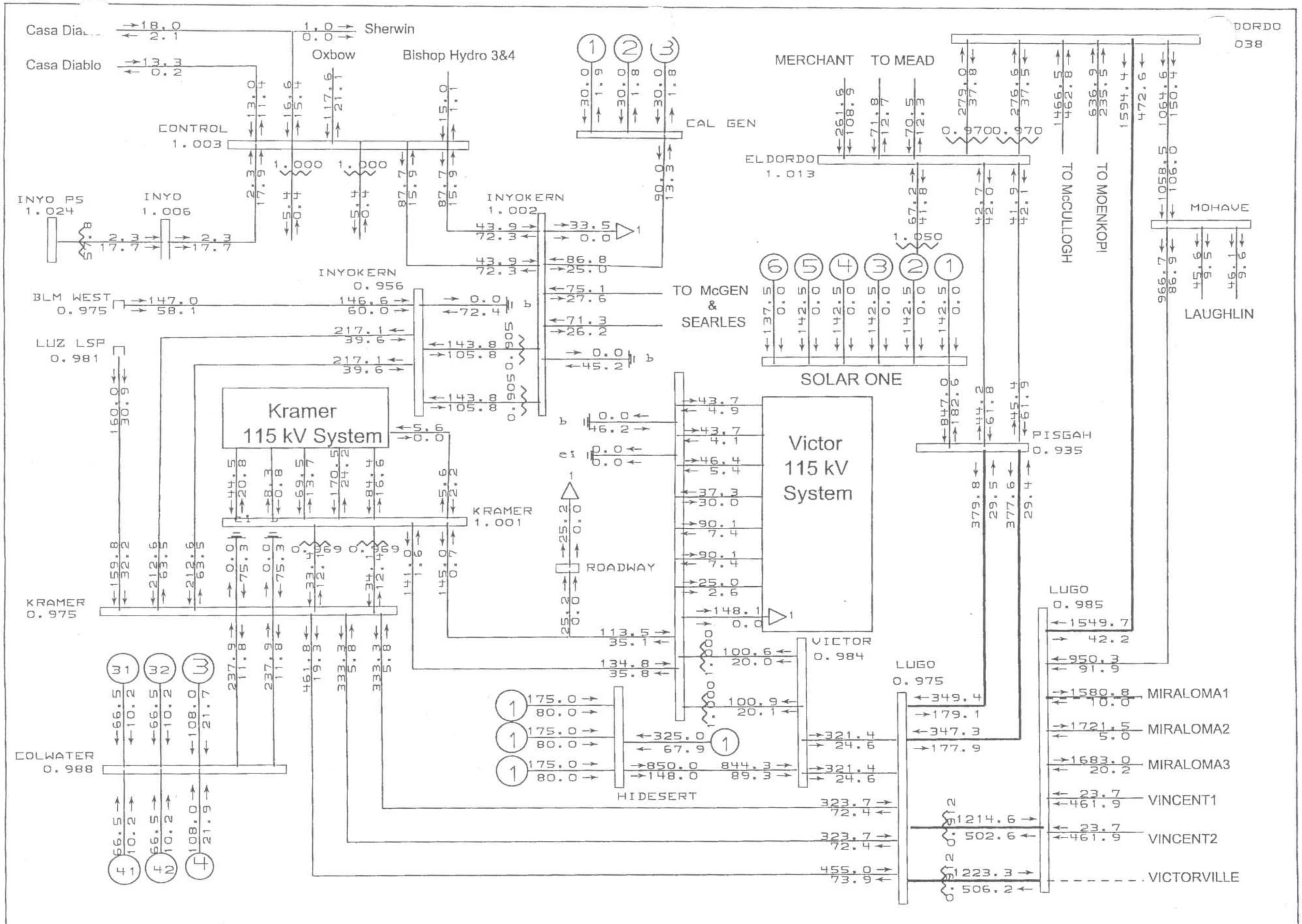

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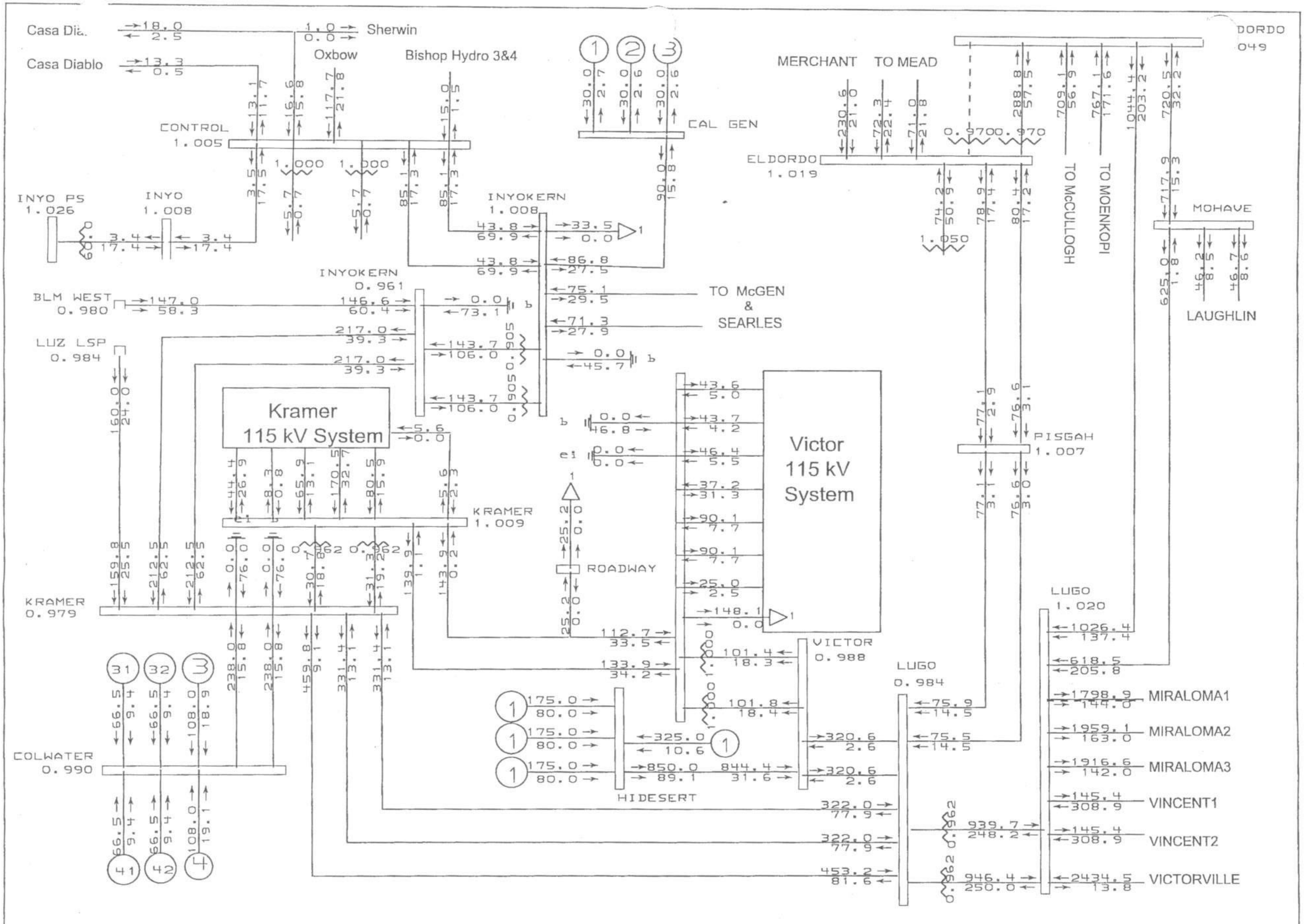

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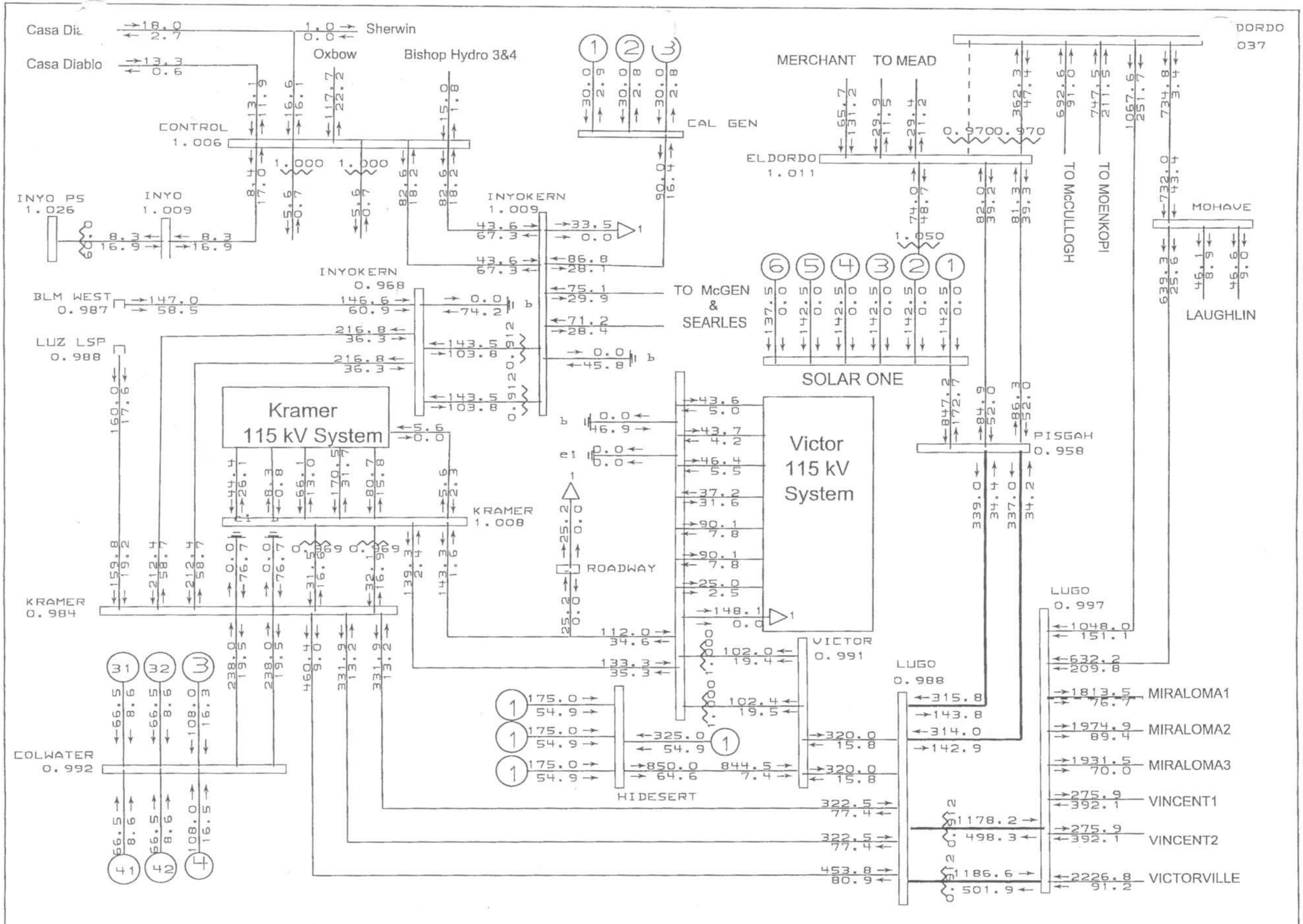

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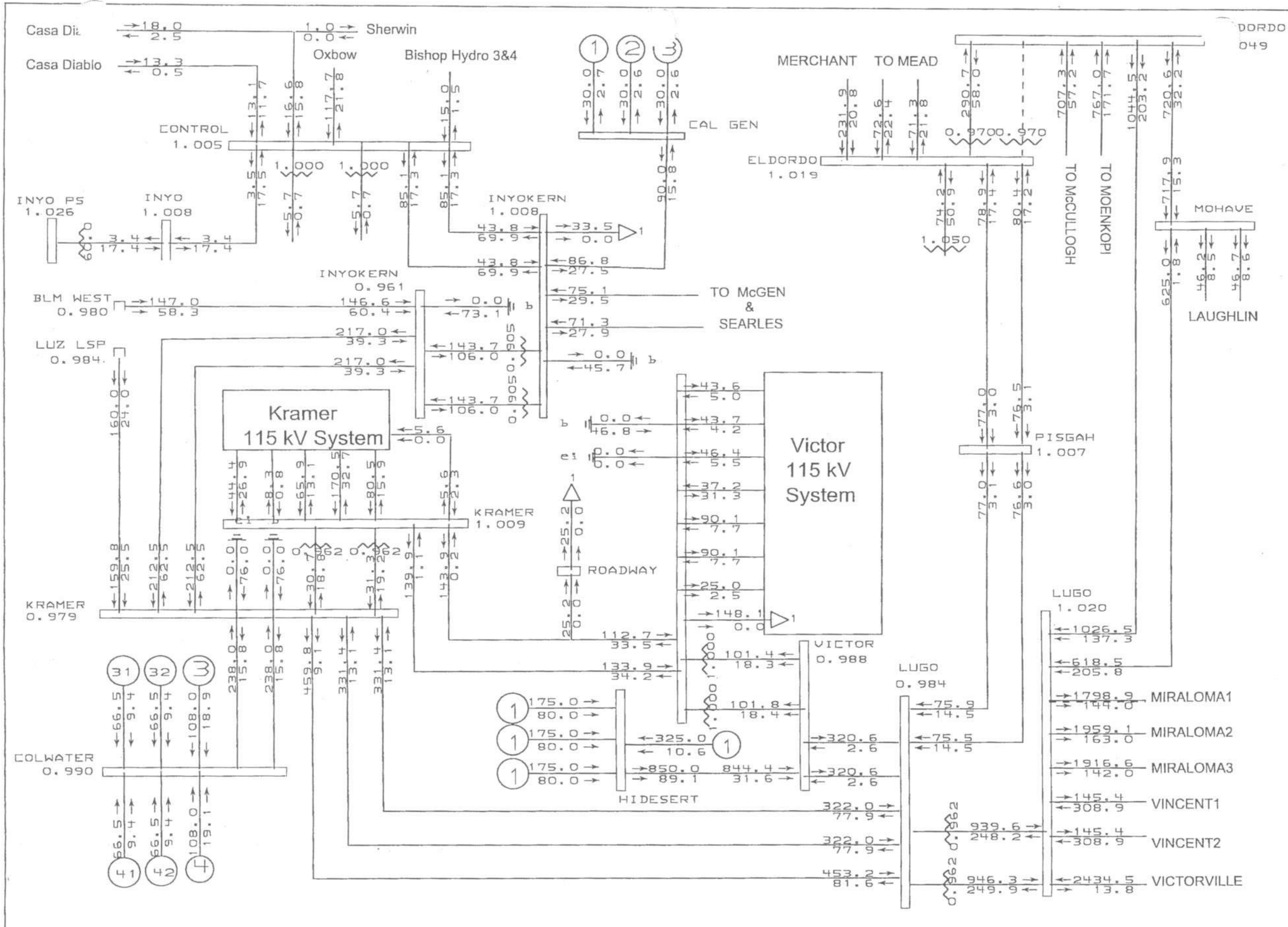

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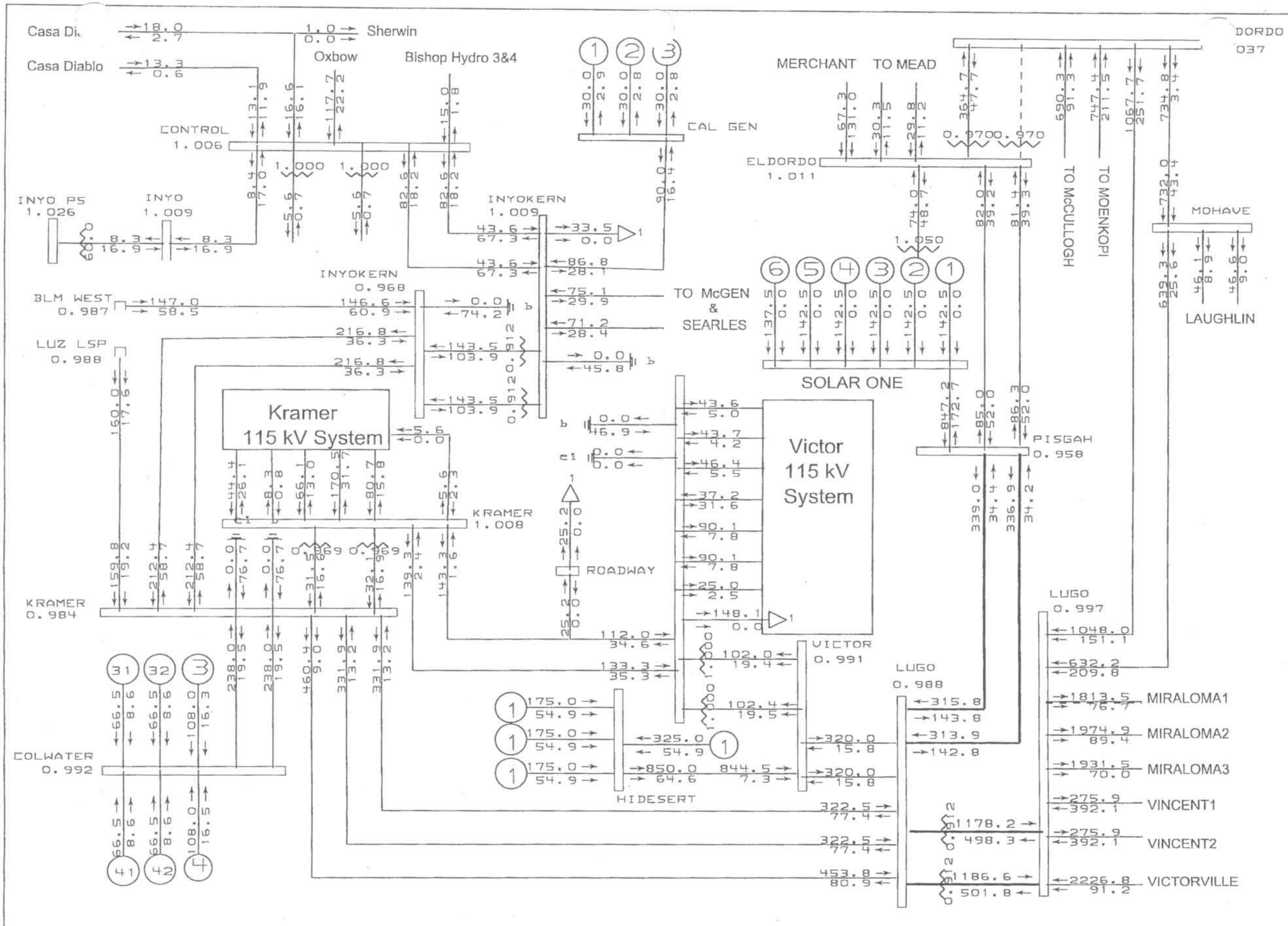

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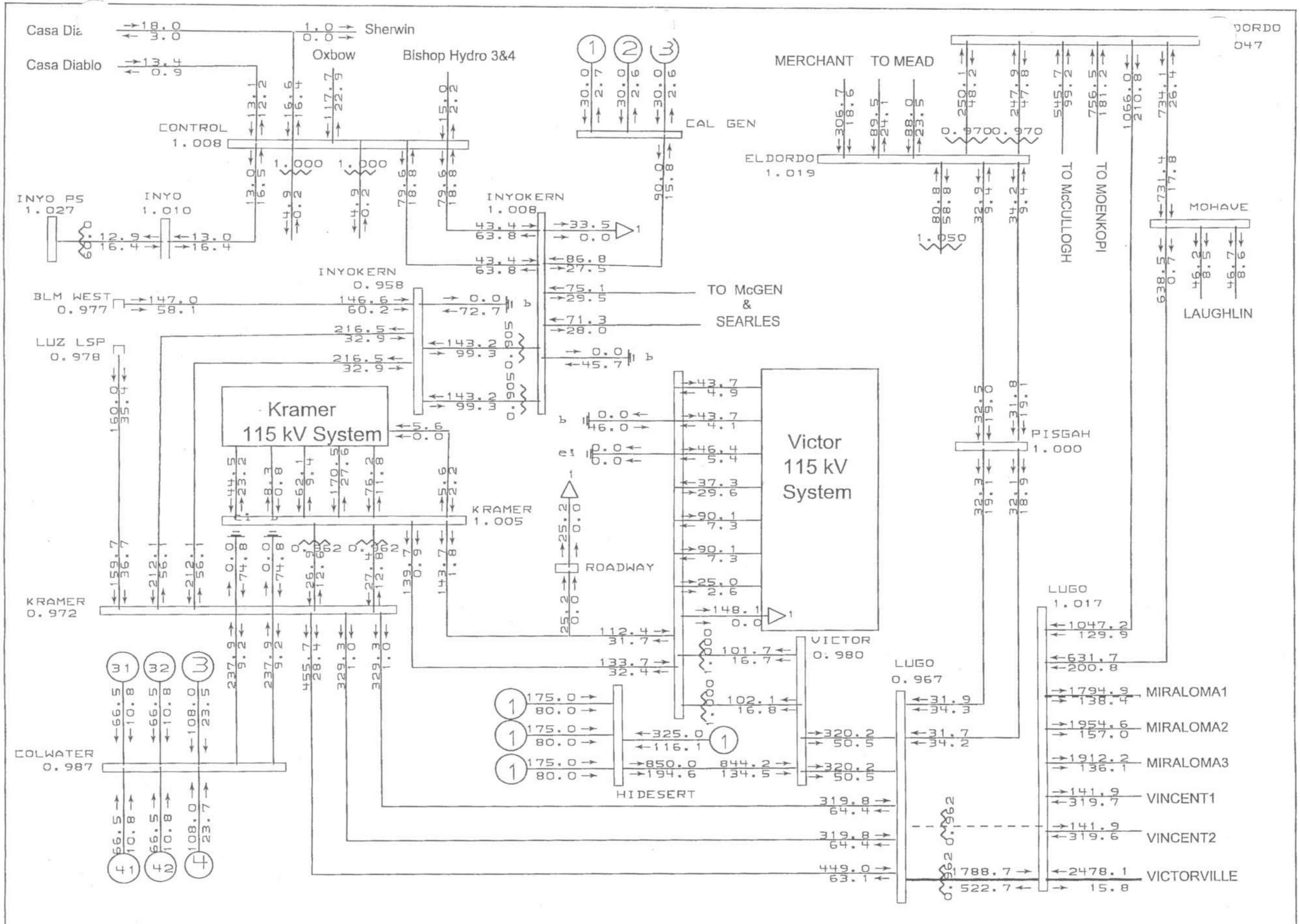

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2009 Heavy Summer Load Conditions
Power Flow Case with Significant Pre-Proj Upgrades

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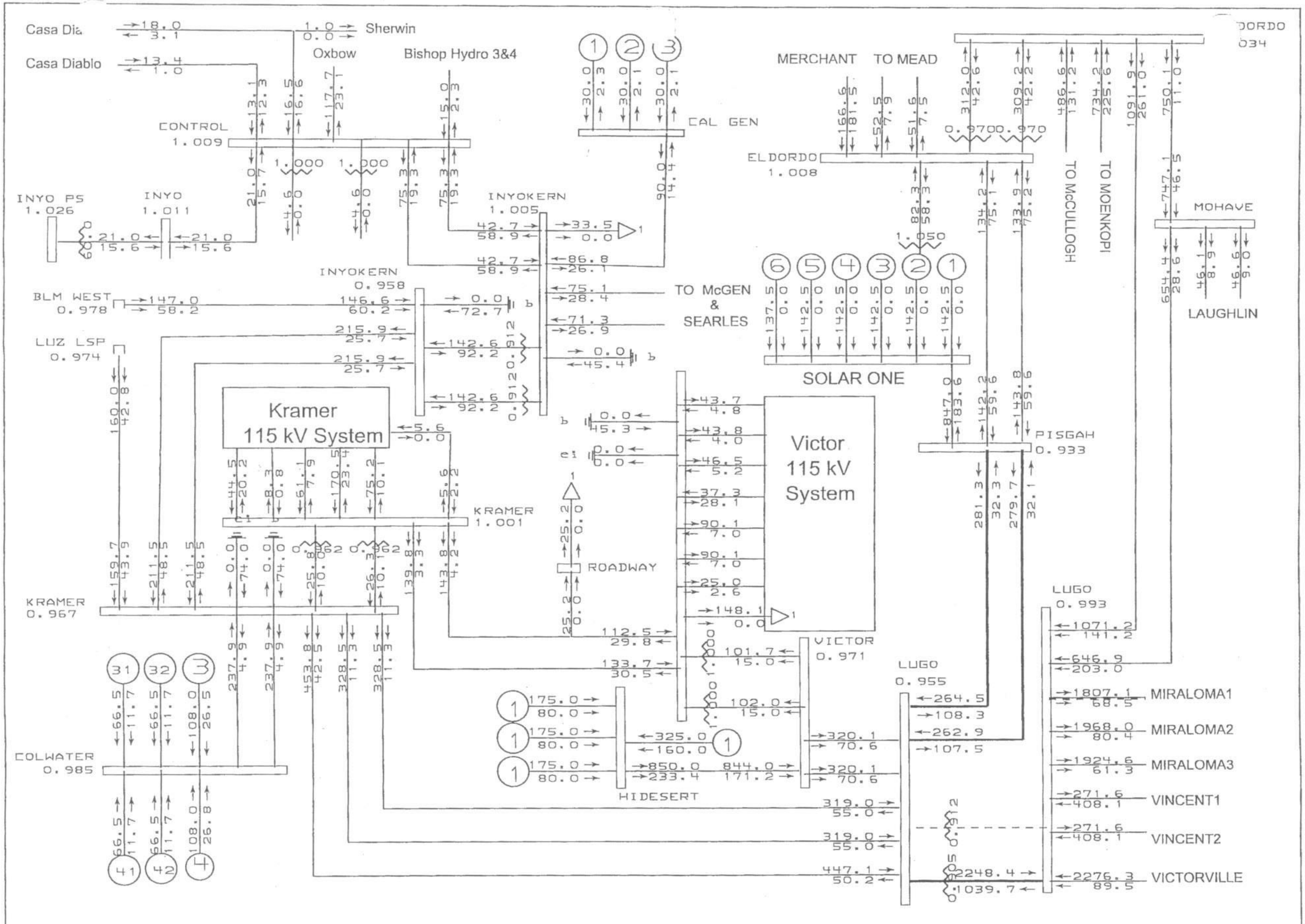

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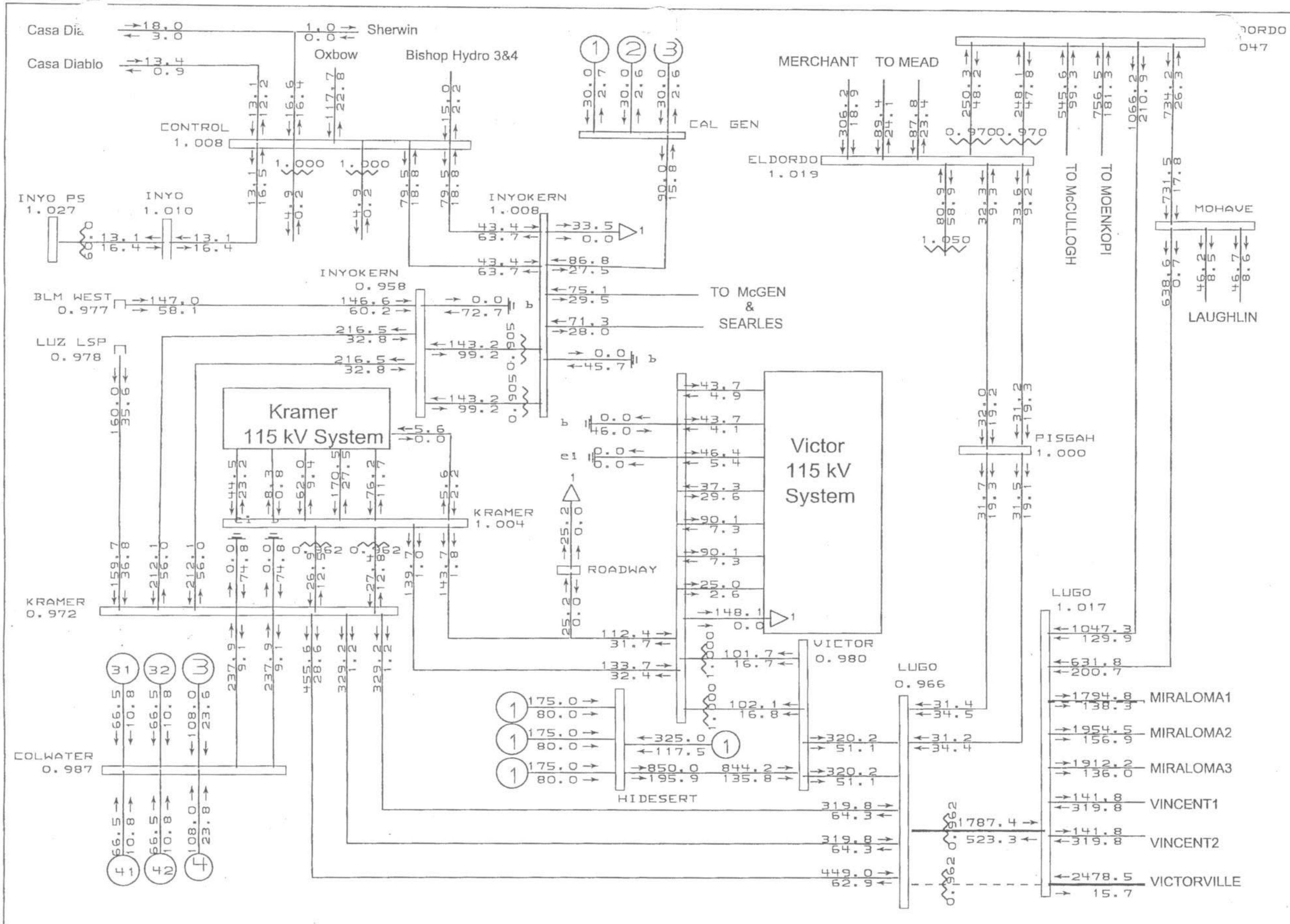

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Solar I System Impact Study: Pre-Project
2009 Heavy Summer Load Conditions
Power Flow Case with Significant Pre-Proj Upgrades

N-1: Lugo No. 2 500/230 kV Transformer

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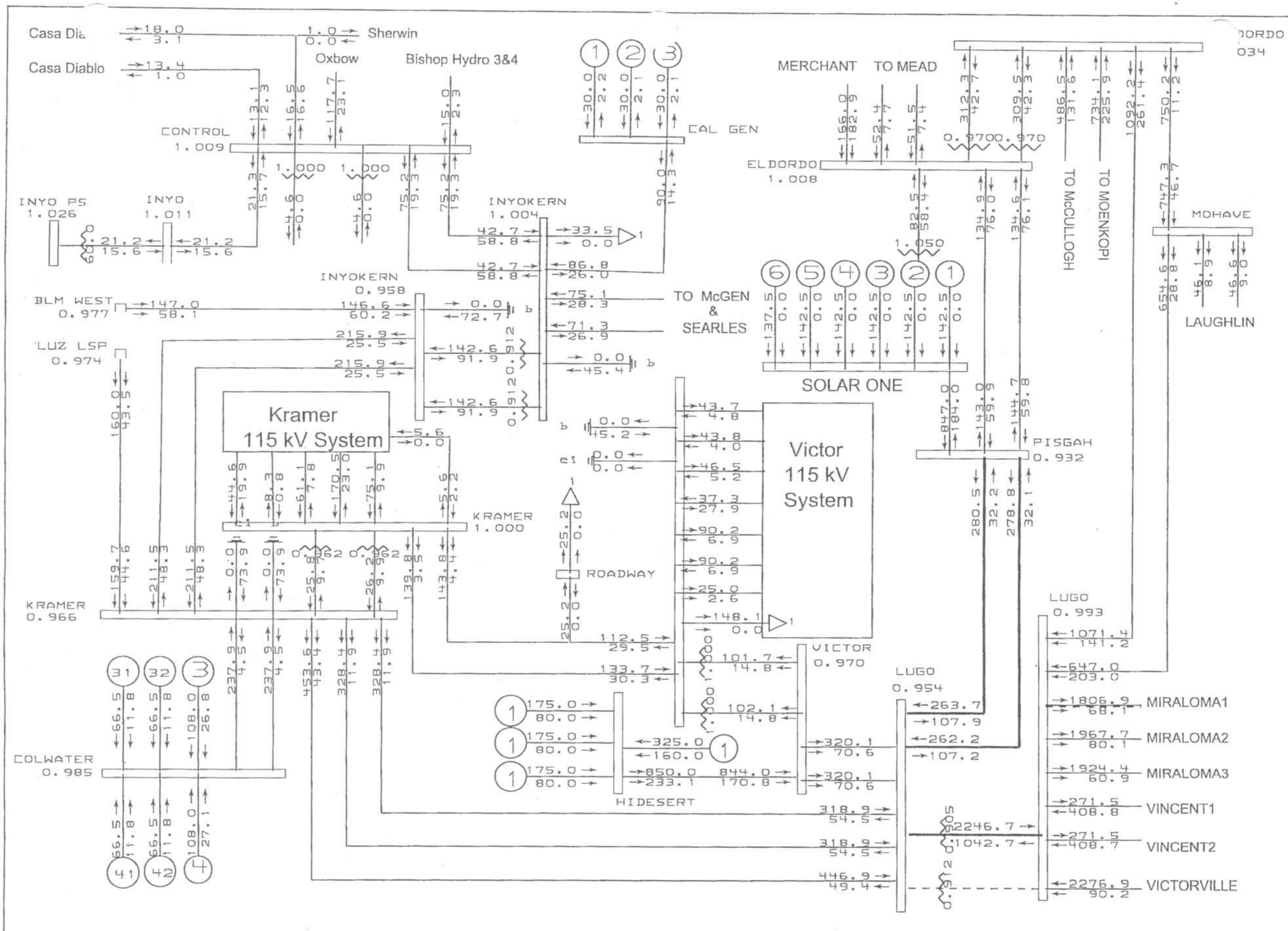

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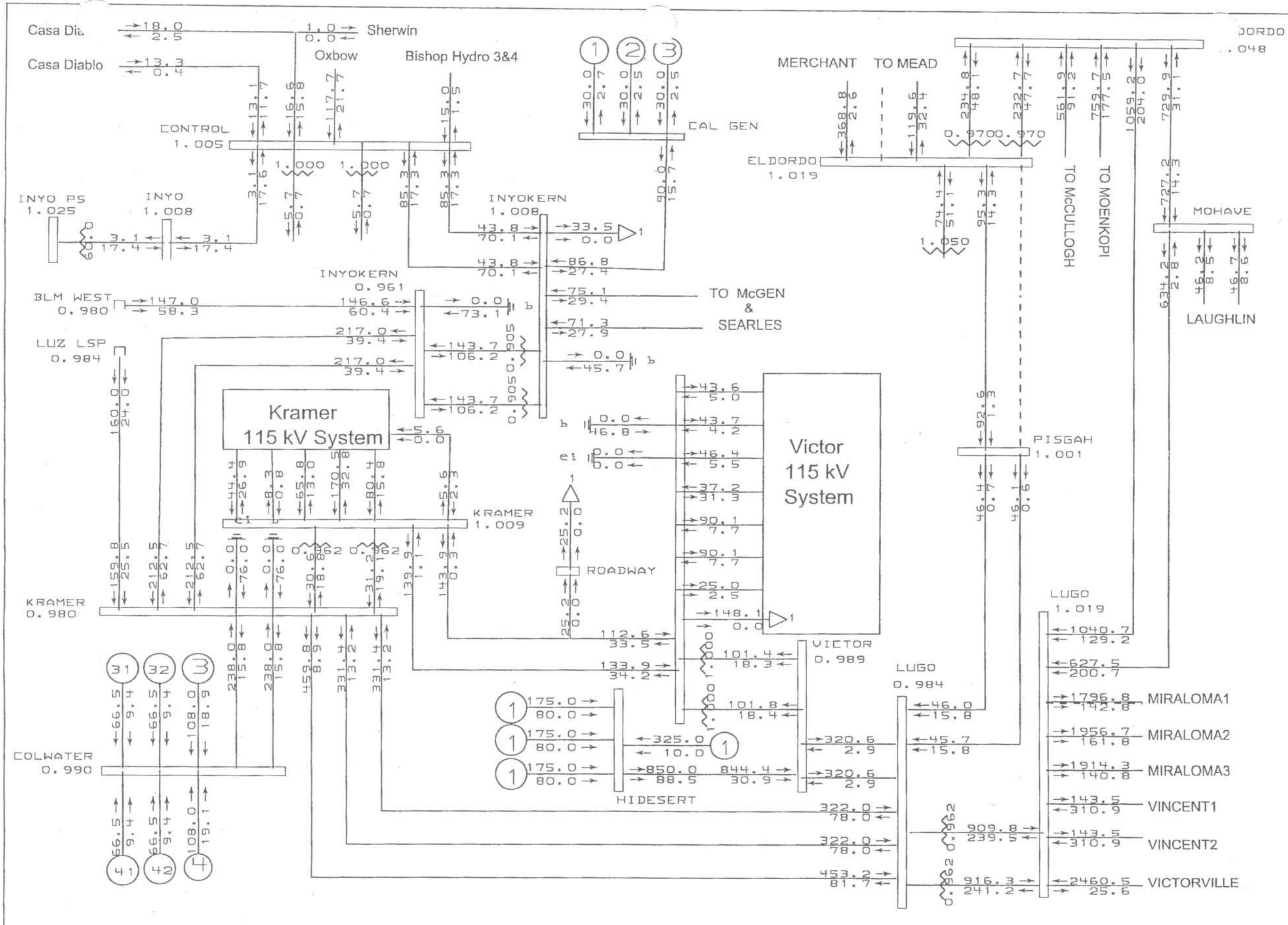

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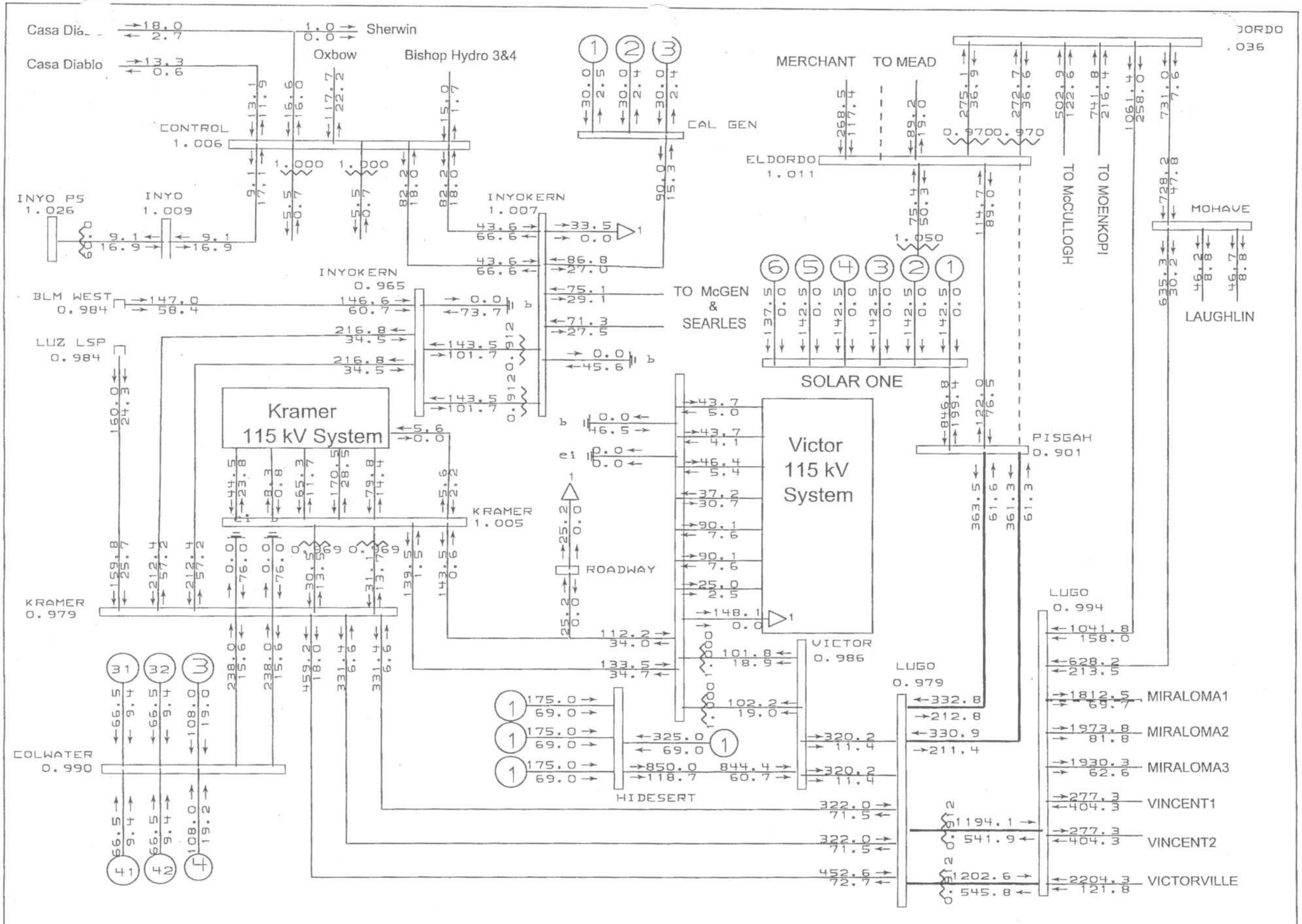

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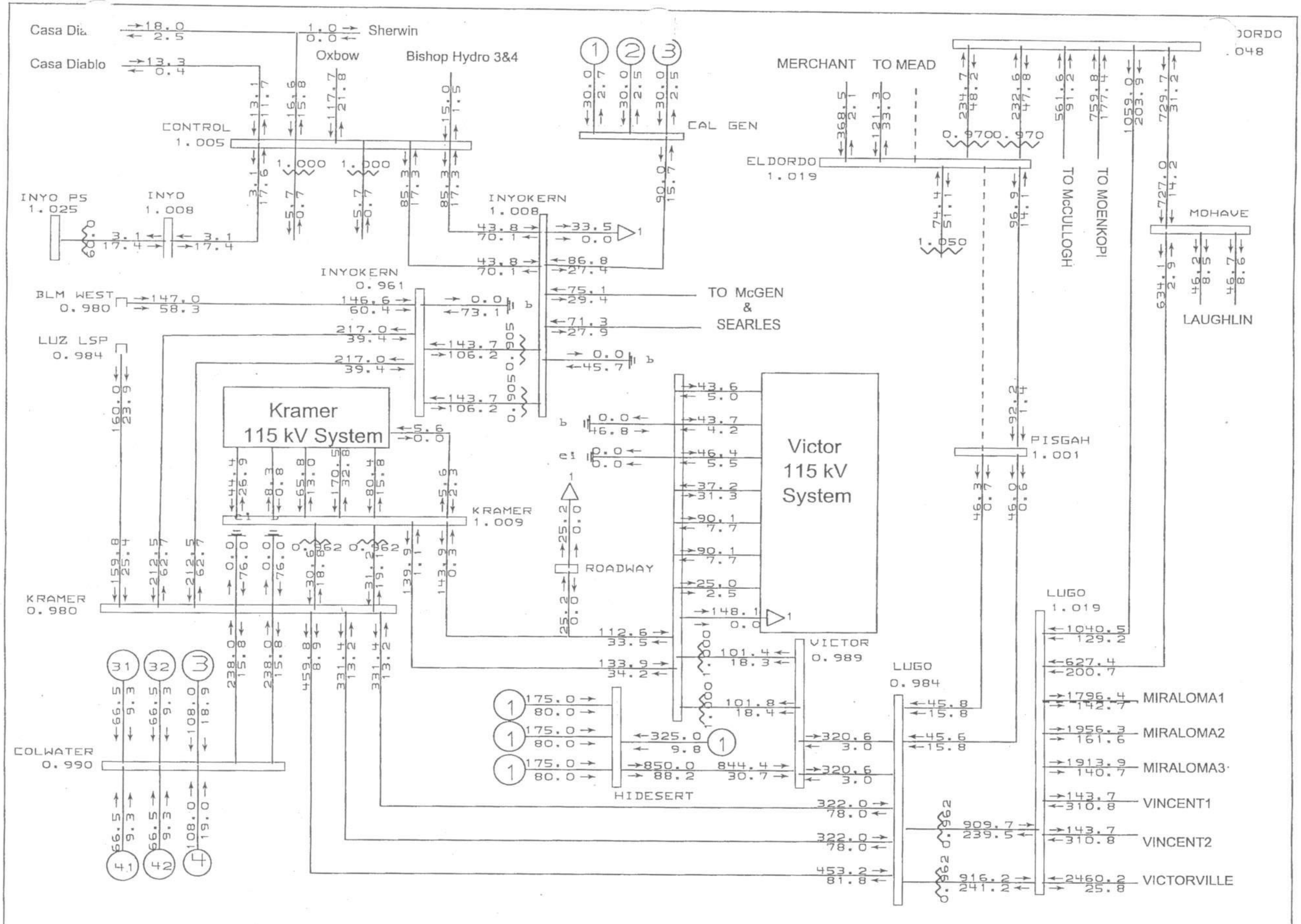

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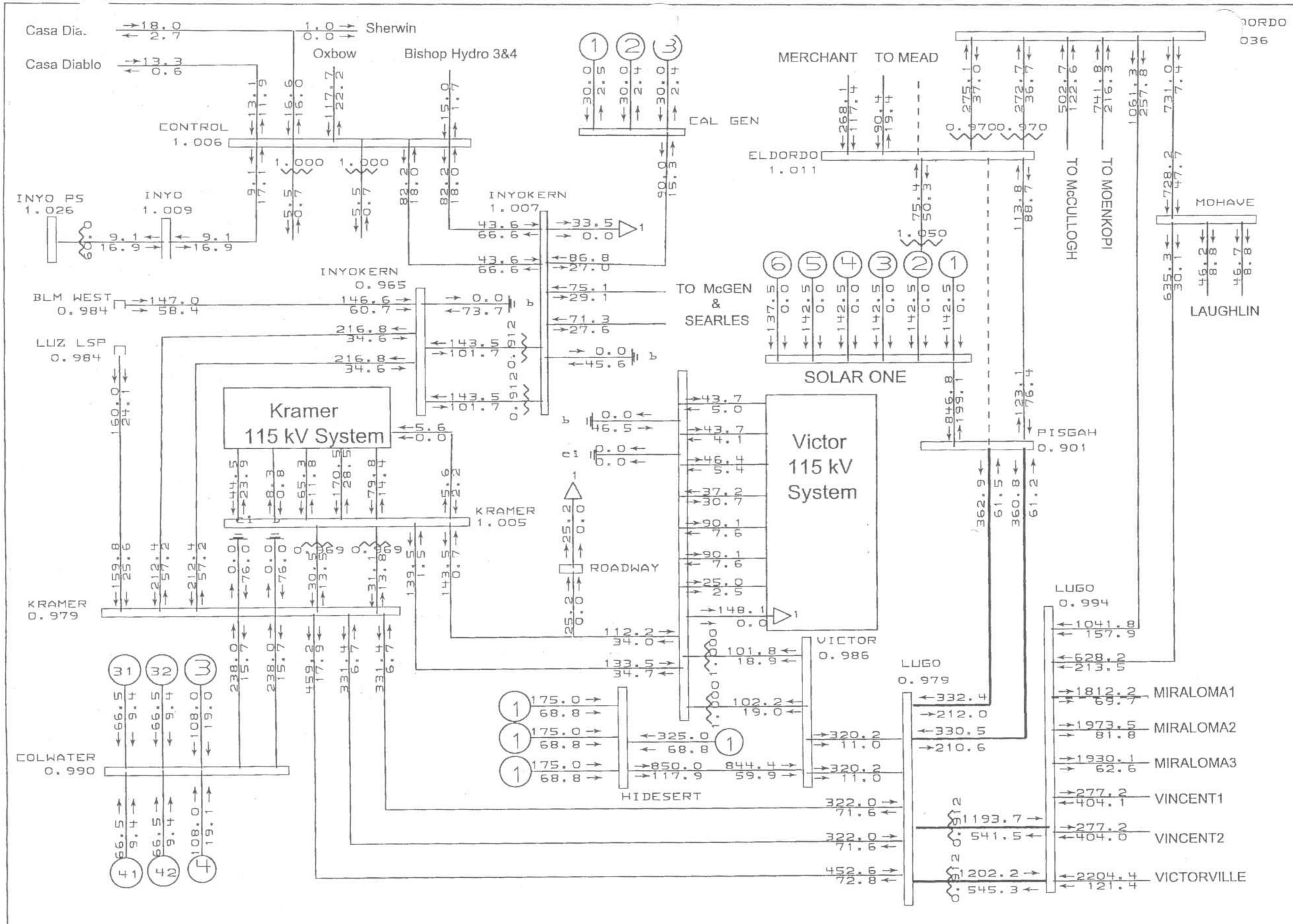

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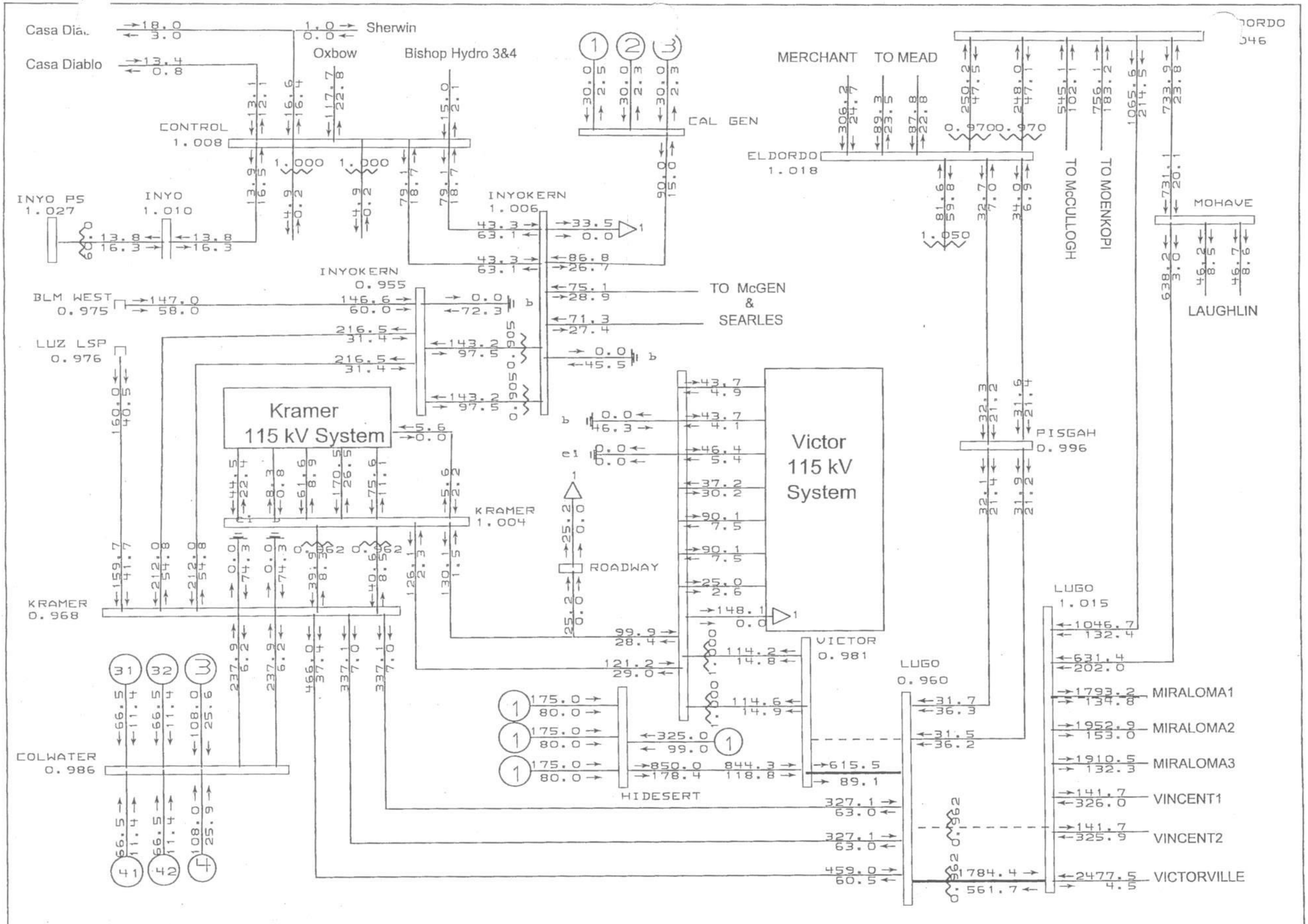

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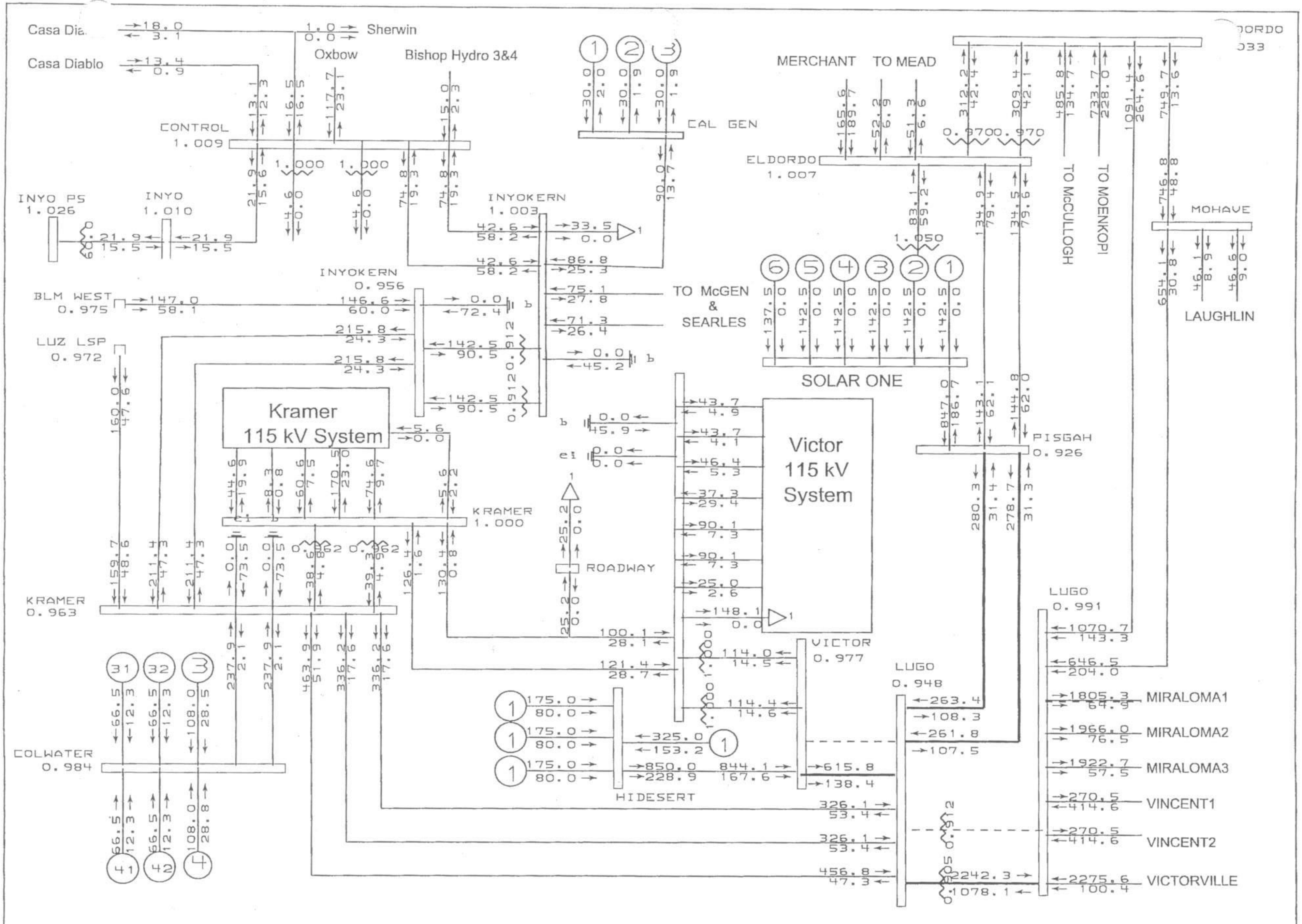

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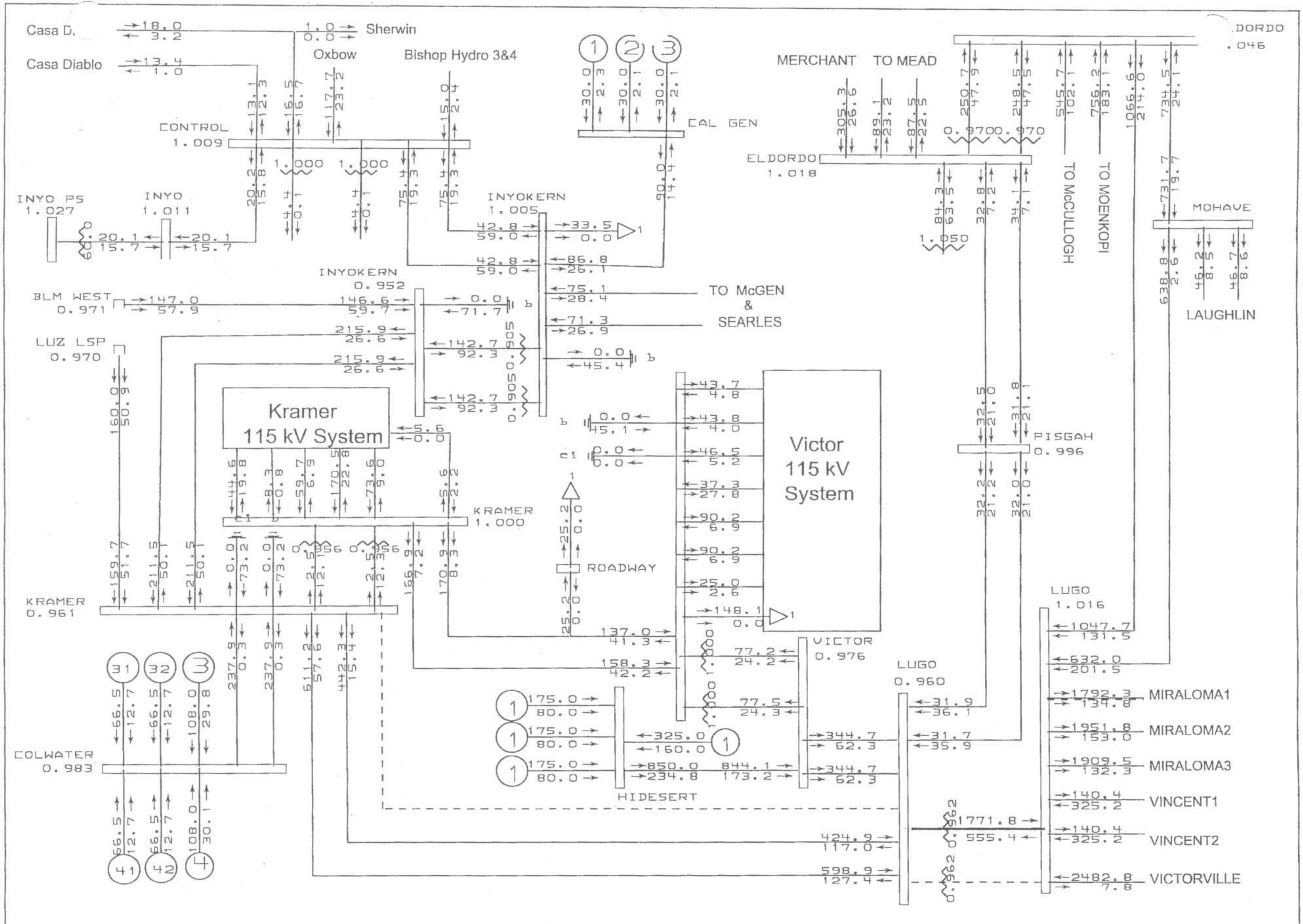

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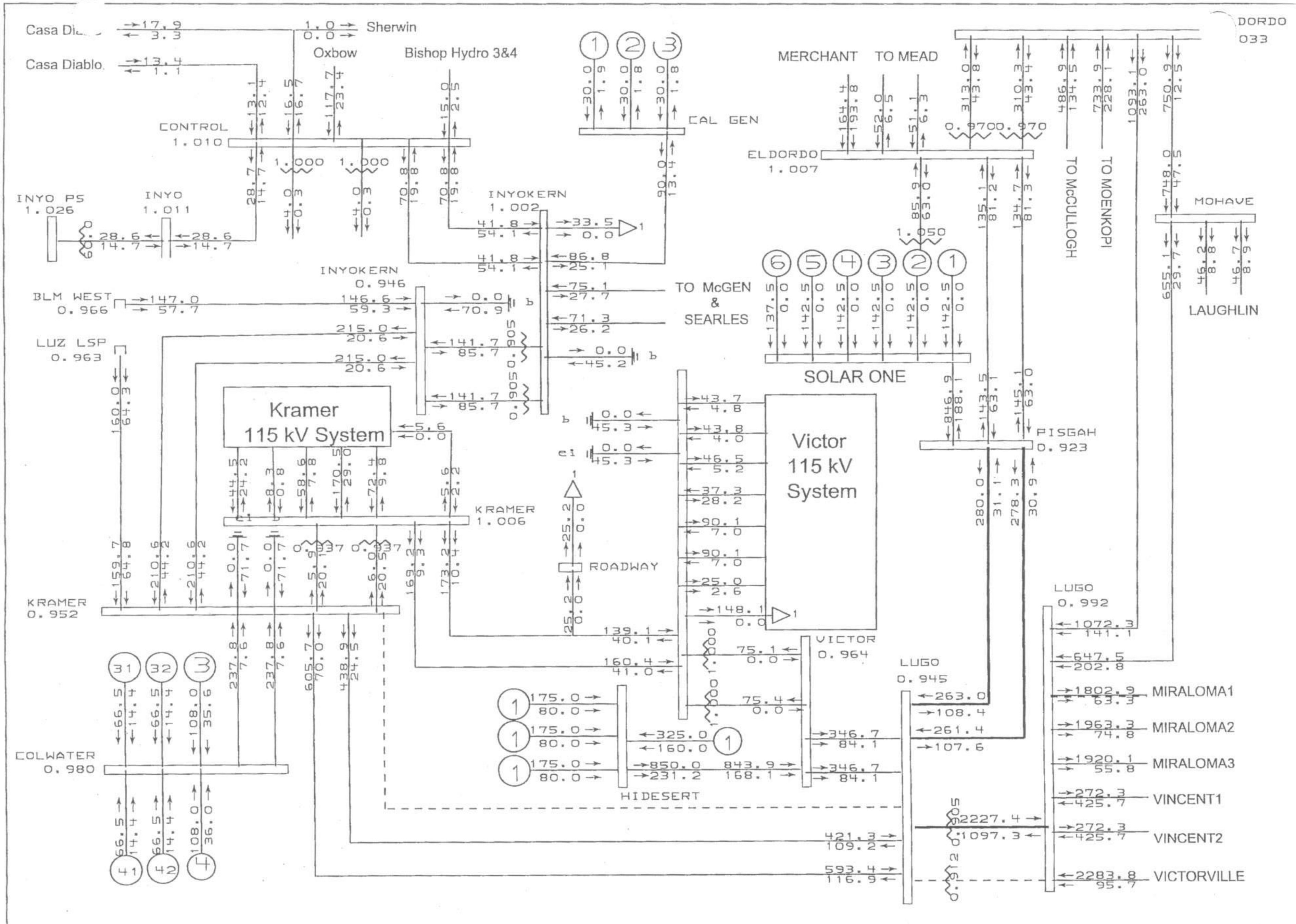

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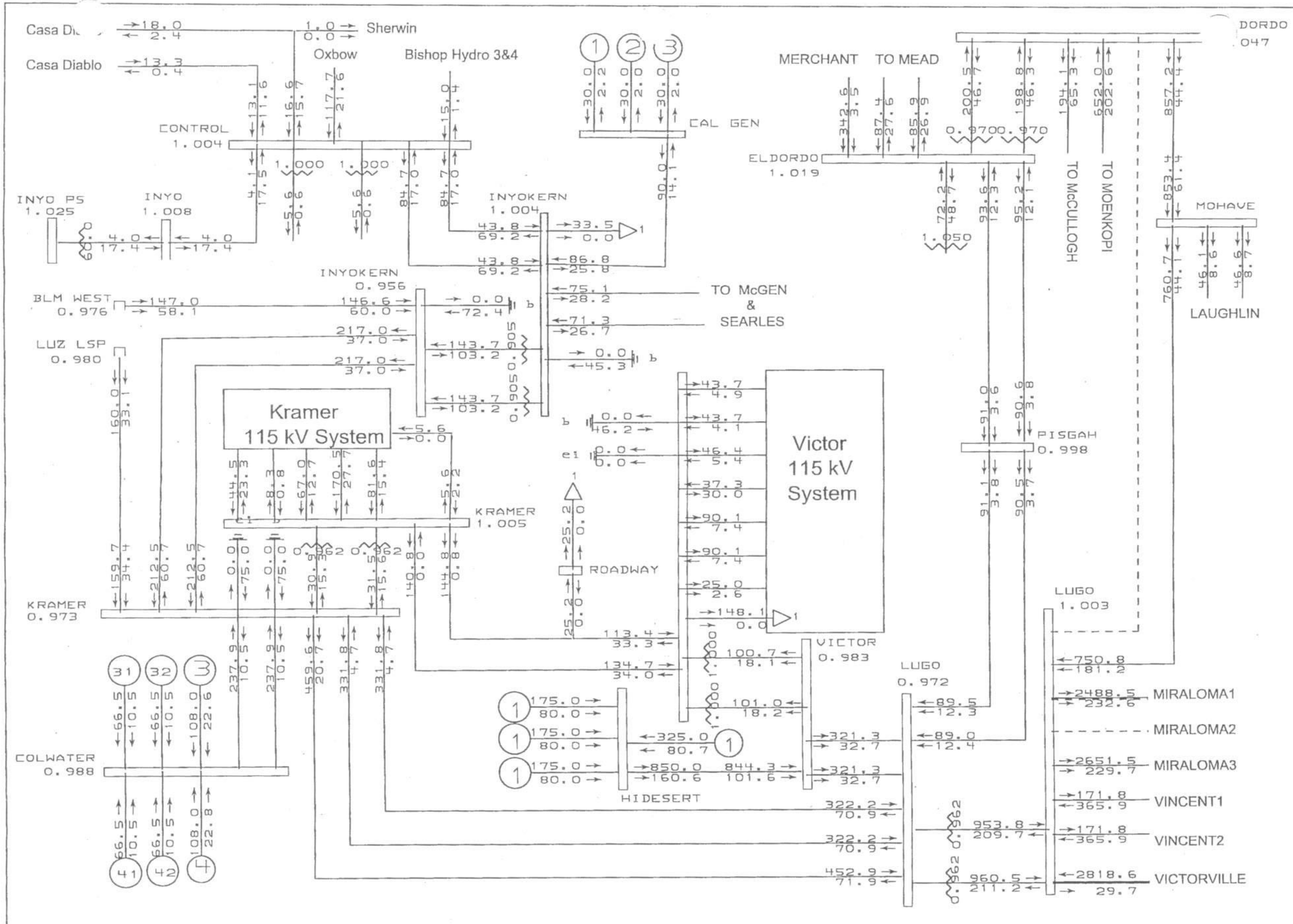
Solar I System Impact Study: Post-Project 2009 Heavy Summer Load Conditions Power Flow Case with SES Plant at 850 MW	N-2: Lugo No. 2 500/230 kV Transformer and Kramer-Lugo No. 2 230 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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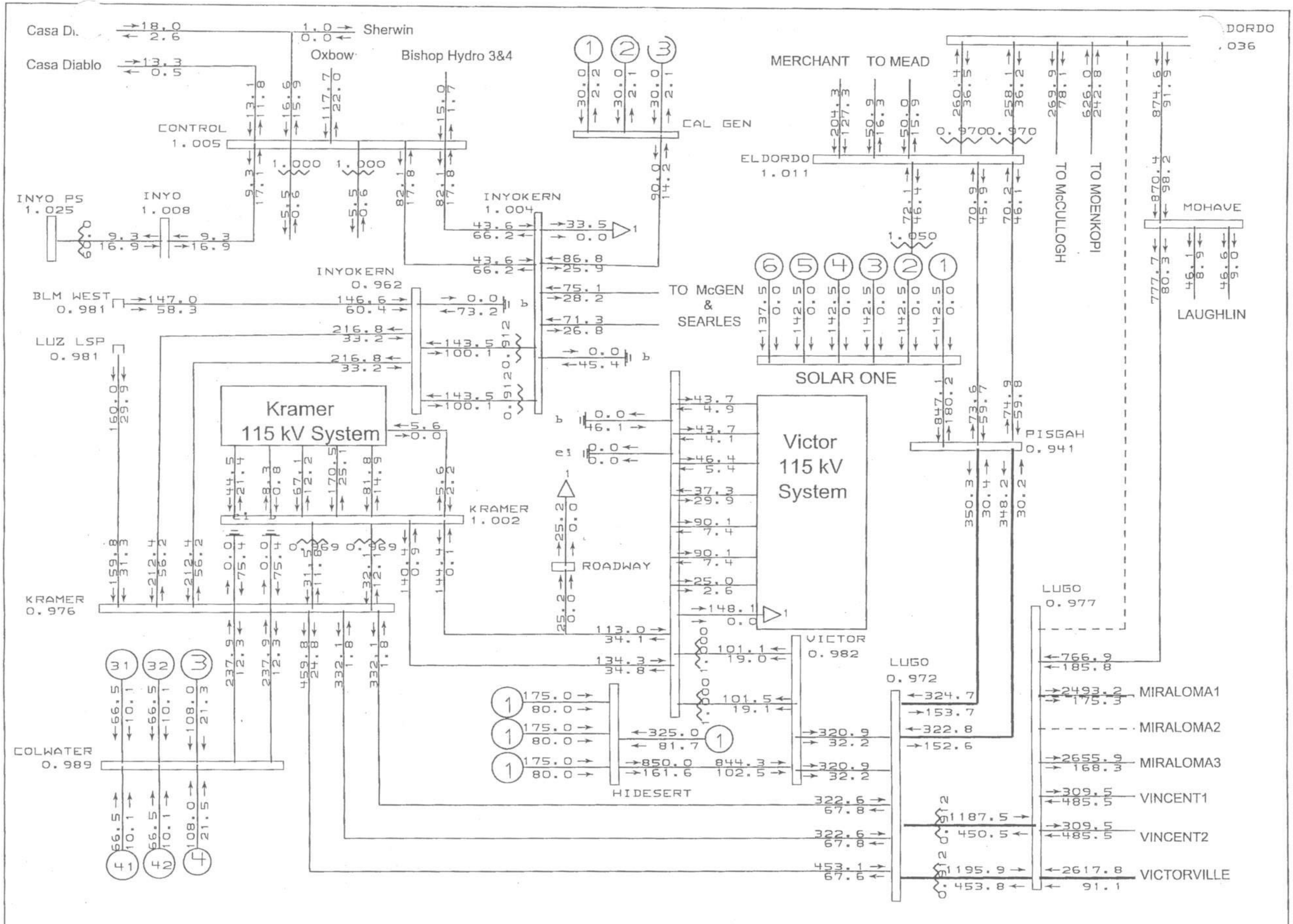
Wed Jan 18 01:20:56 2006

	Solar I System Impact Study: Pre-Project 2009 Heavy Summer Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-2: Lugo-Mira Loma No. 2 500 kV Line and Eldorado-Lugo 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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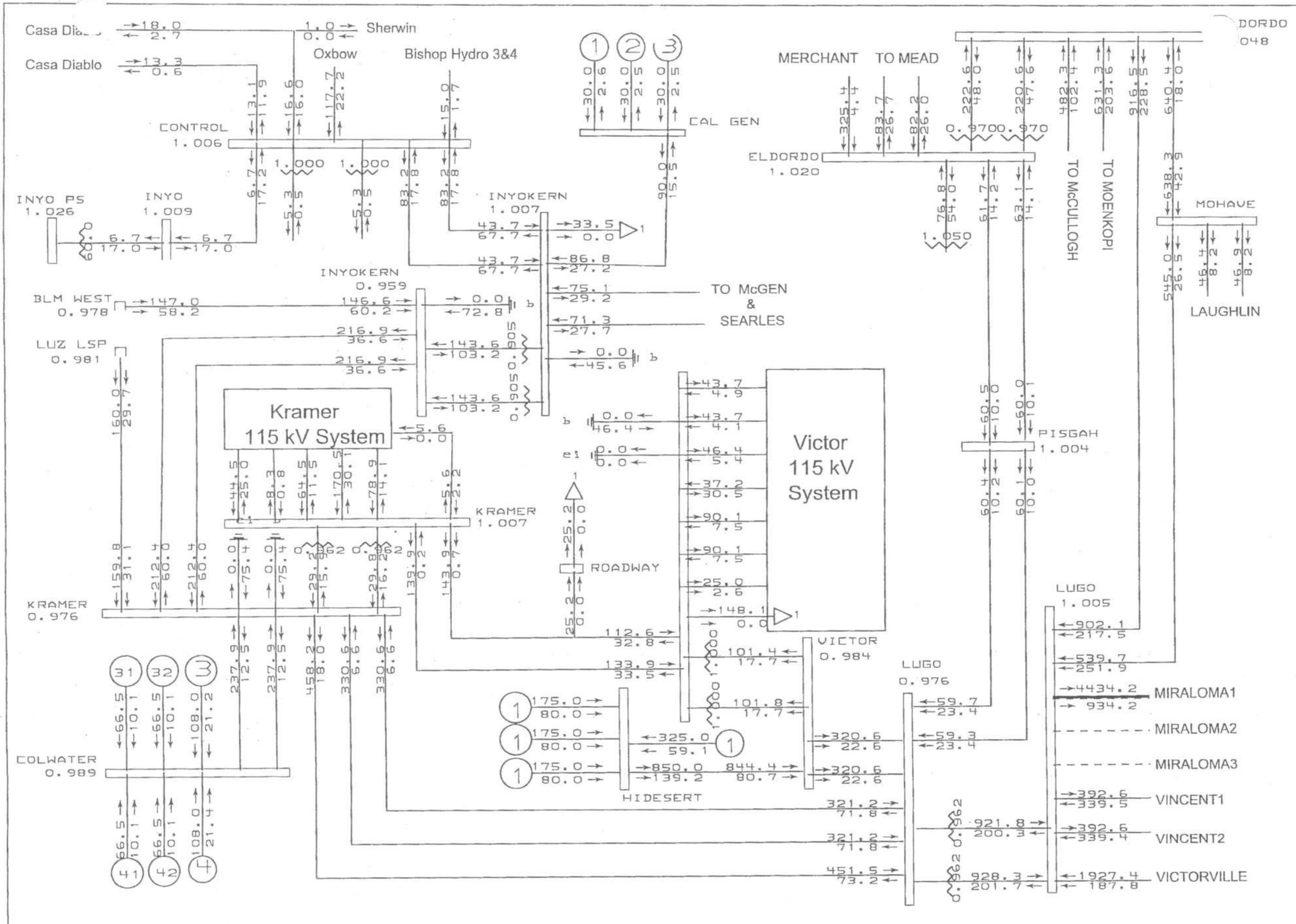
Wed Jan 18 01:21:56 2006

	Solar I System Impact Study: Post-Project 2009 Heavy Summer Load Conditions Power Flow Case with SES Plant at 850 MW	N-2: Lugo-Mira Loma No. 2 500 kV Line and Eldorado-Lugo 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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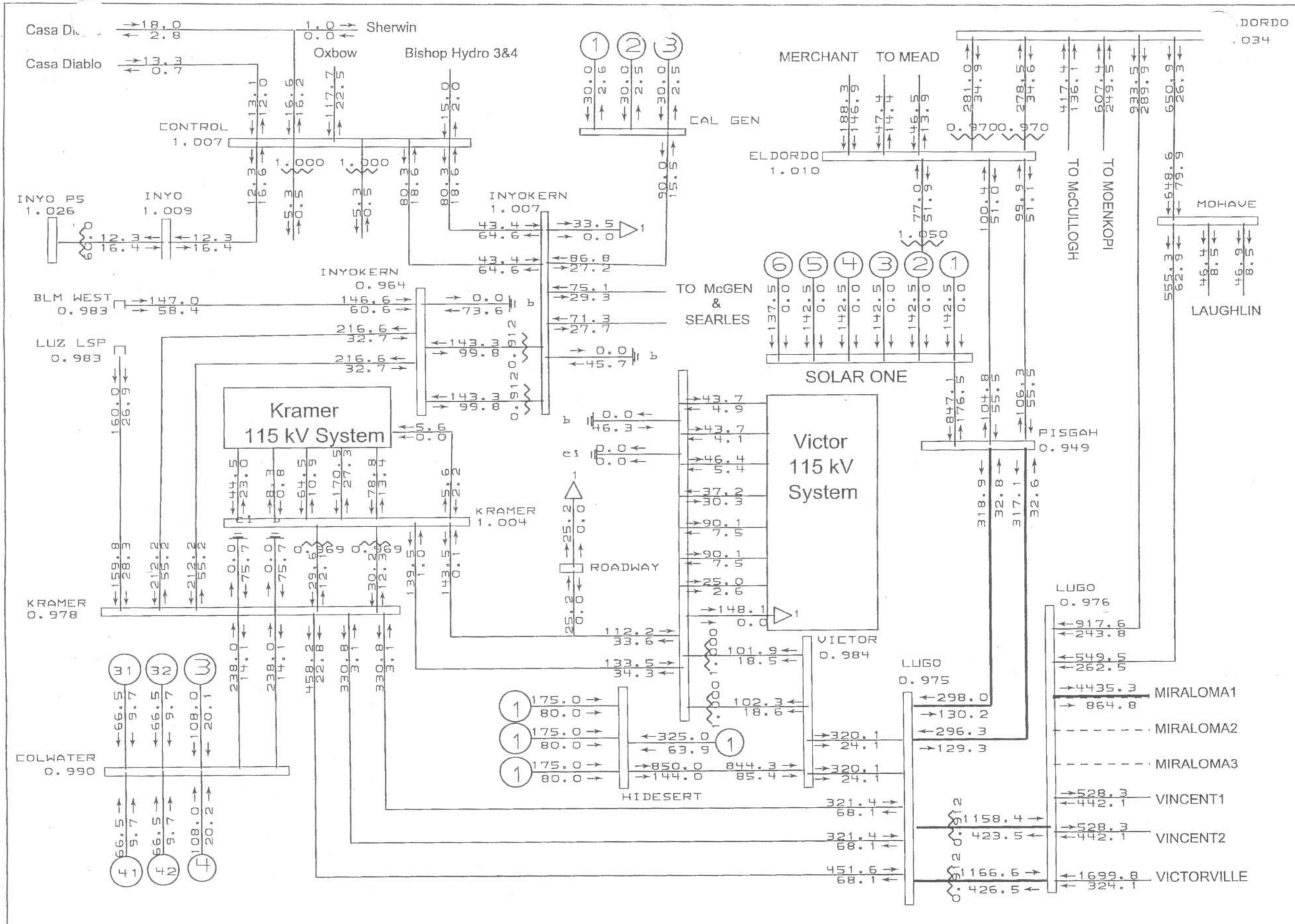
Wed Jan 18 01:20:52 2006

	Solar I System Impact Study: Pre-Project 2009 Heavy Summer Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-2: Lugo-Mira Loma No. 2 500 kV Line and Lugo-Mira Loma No. 3 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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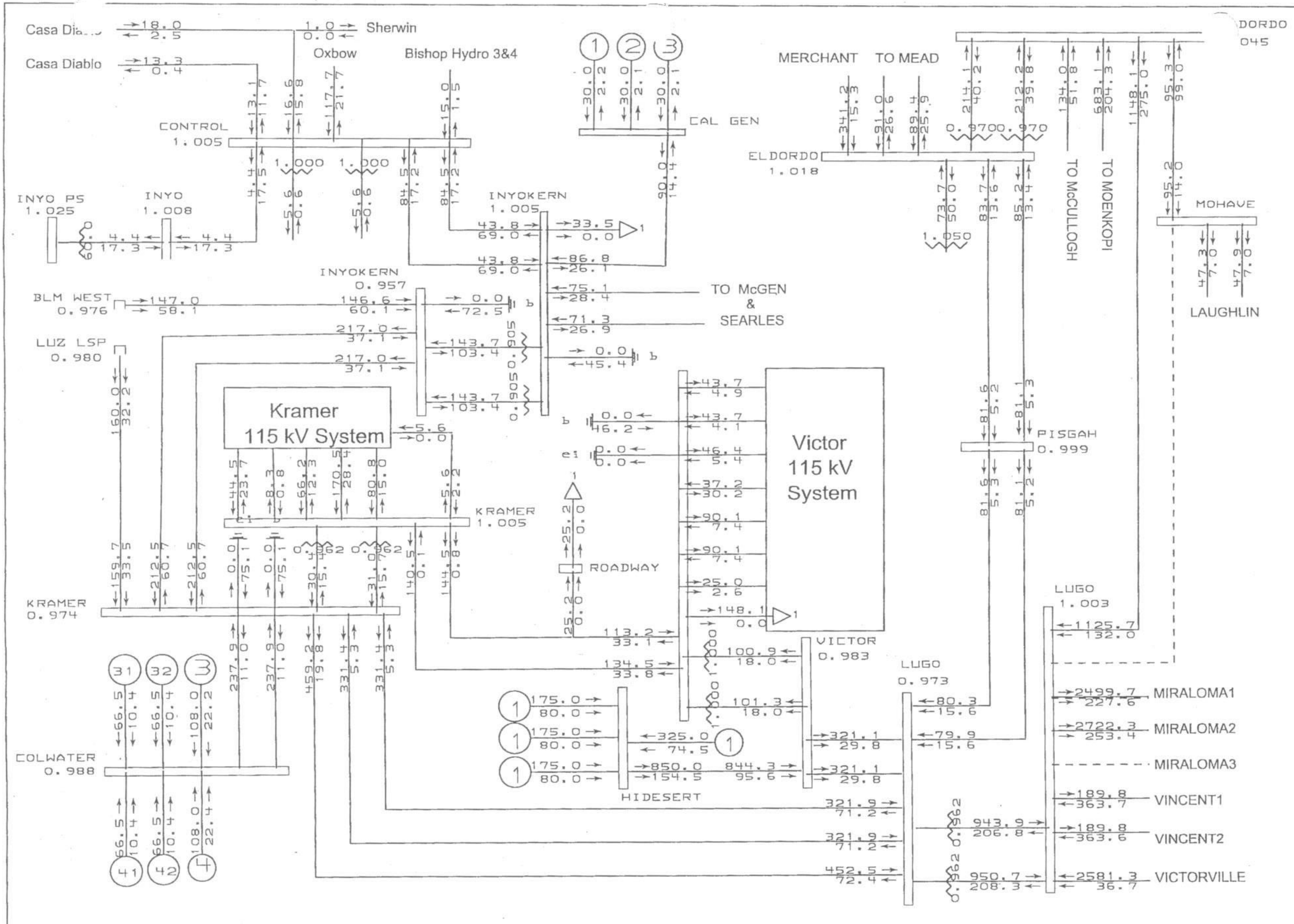
Wed Jan 18 01:21:53 2006

Solar I System Impact Study: Post-Project 2009 Heavy Summer Load Conditions Power Flow Case with SES Plant at 850 MW	N-2: Lugo-Mira Loma No. 2 500 kV Line and Lugo-Mira Loma No. 3 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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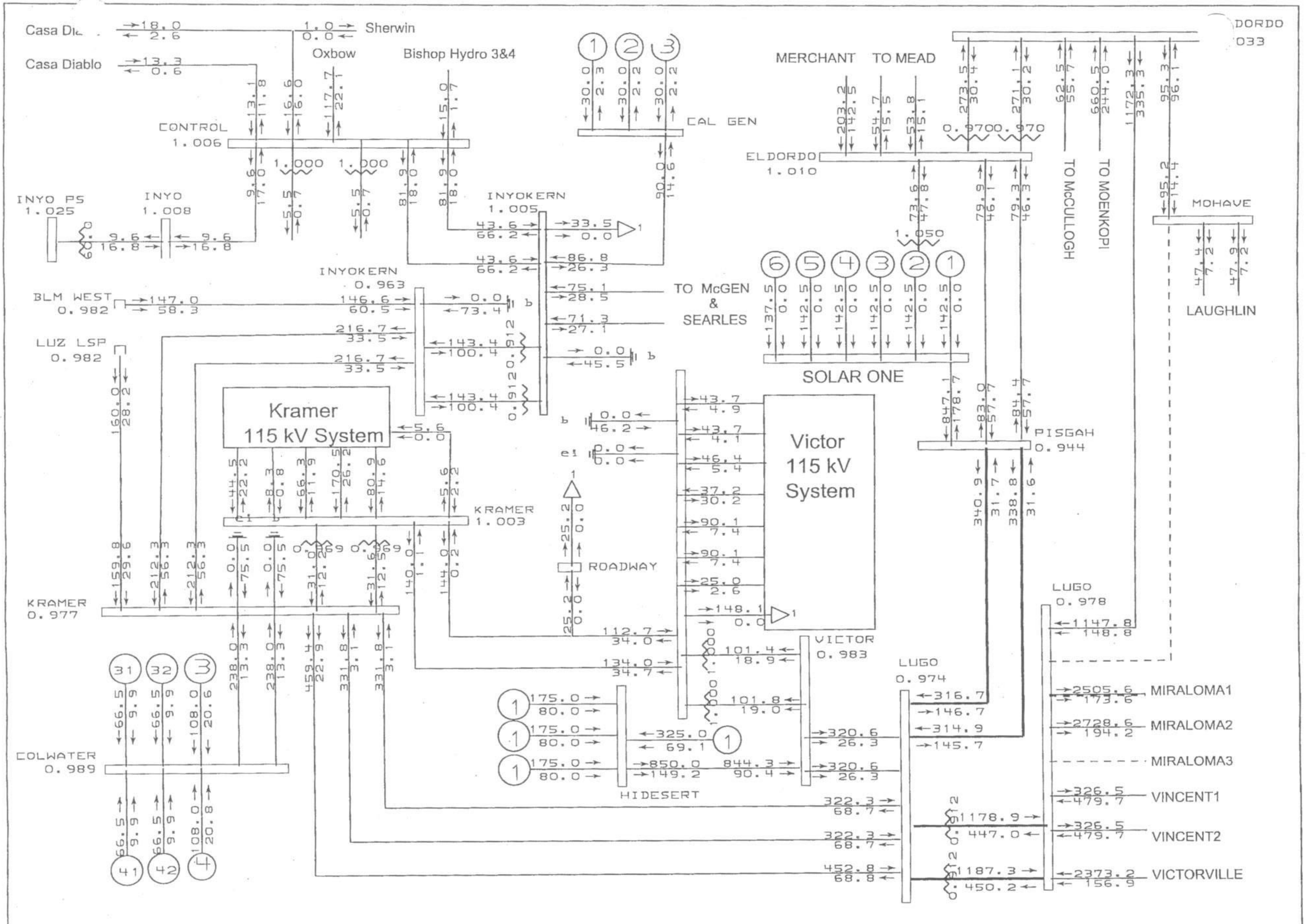
Wed Jan 18 01:21:00 2006

GE	Solar I System Impact Study: Pre-Project 2009 Heavy Summer Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-2: Lugo-Mira Loma No. 3 500 kV Line and Lugo-Mohave 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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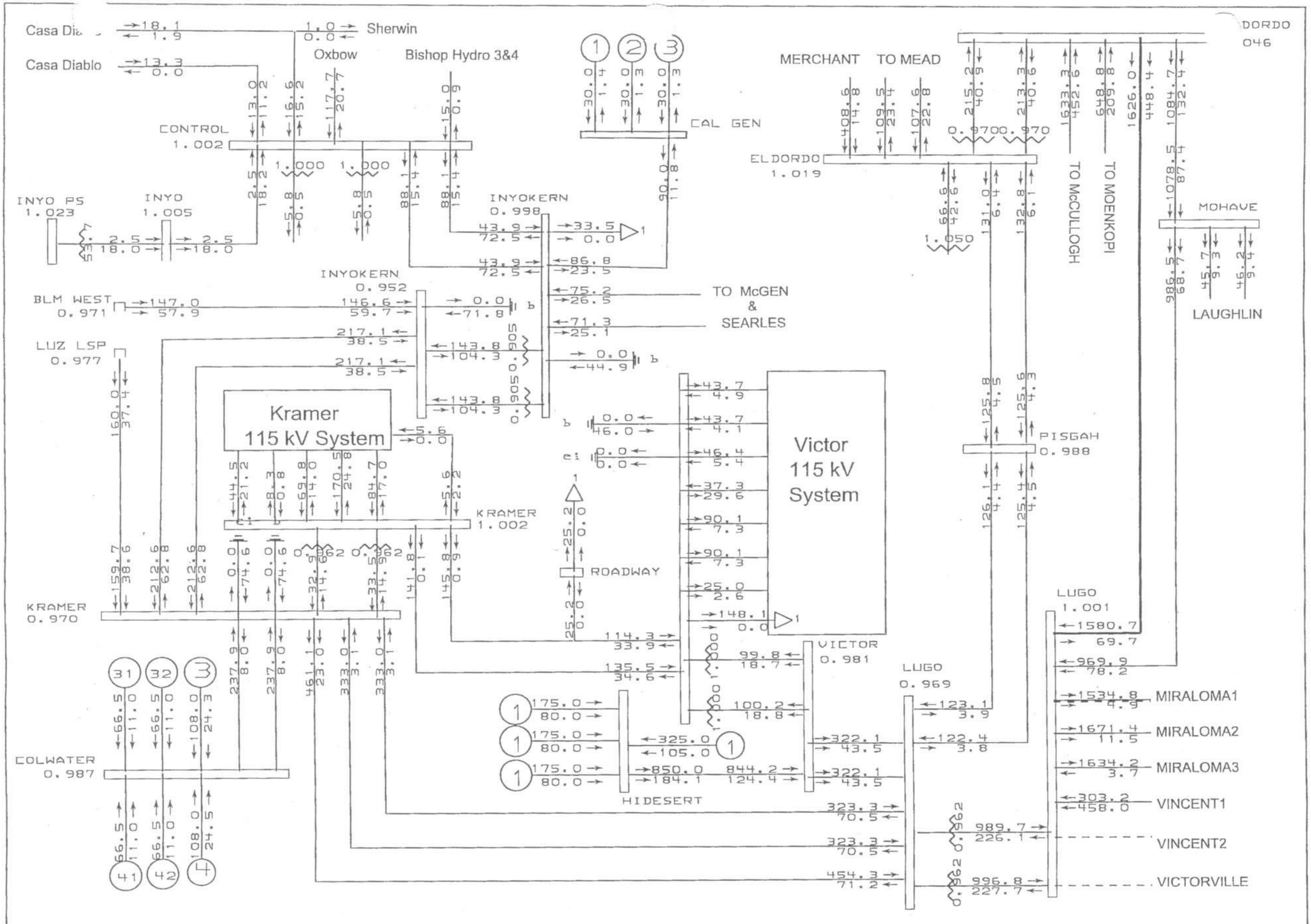
Wed Jan 18 01:22:00 2006

Solar I System Impact Study: Post-Project
2009 Heavy Summer Load Conditions
Power Flow Case with SES Plant at 850 MW

N-2: Lugo-Mira Loma No. 3 500 kV Line
and Lugo-Mohave 500 kV Line

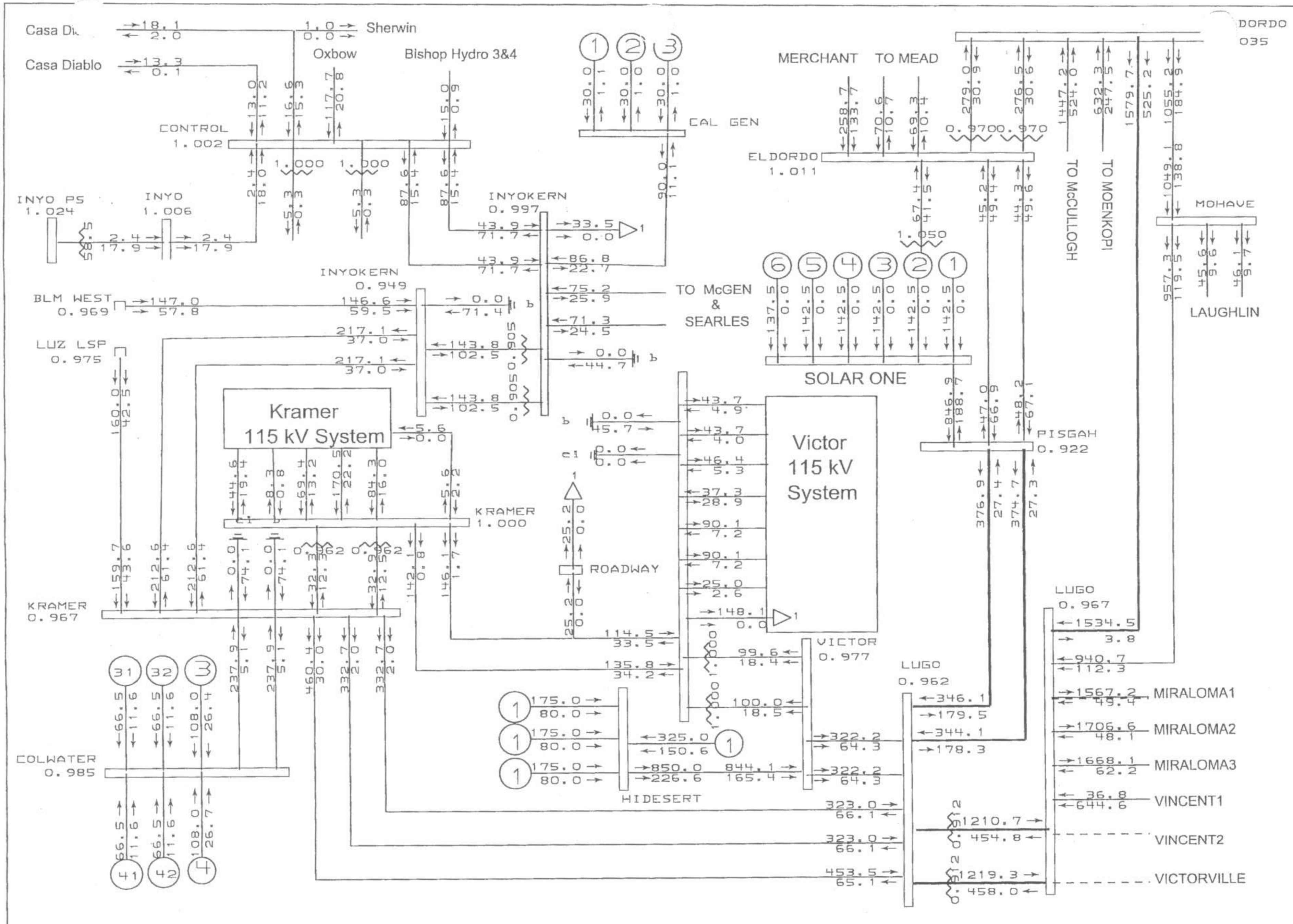
PSLF Program
C:\upslf143\MyP
Rating =2



C:\upslf143\MyPSLF\cases_2\1_pre_lgo-victrv_n_lgo-vcnt_2.sav

Wed Jan 18 01:21:04 2006

Solar I System Impact Study: Pre-Project 2009 Heavy Summer Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-2: Lugo-Victorville 500 kV Line and Lugo-Vincent No. 2 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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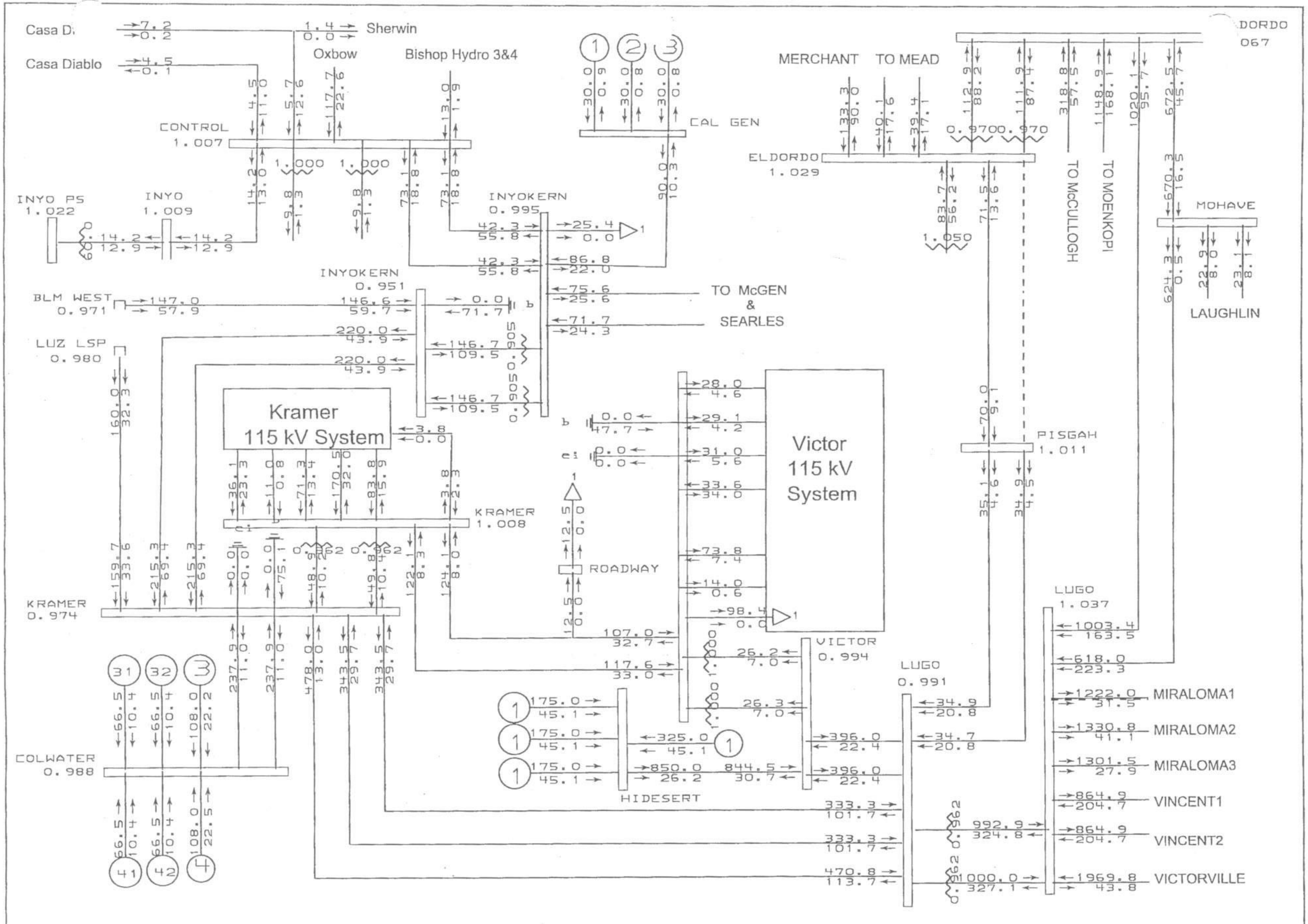
Wed Jan 18 01:22:03 2006

Solar I System Impact Study: Post-Project 2009 Heavy Summer Load Conditions Power Flow Case with SES Plant at 850 MW	N-2: Lugo-Victorville 500 kV Line and Lugo-Vincent No. 2 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2

APPENDIX B

LIGHT SPRING
POWER FLOW PLOTS



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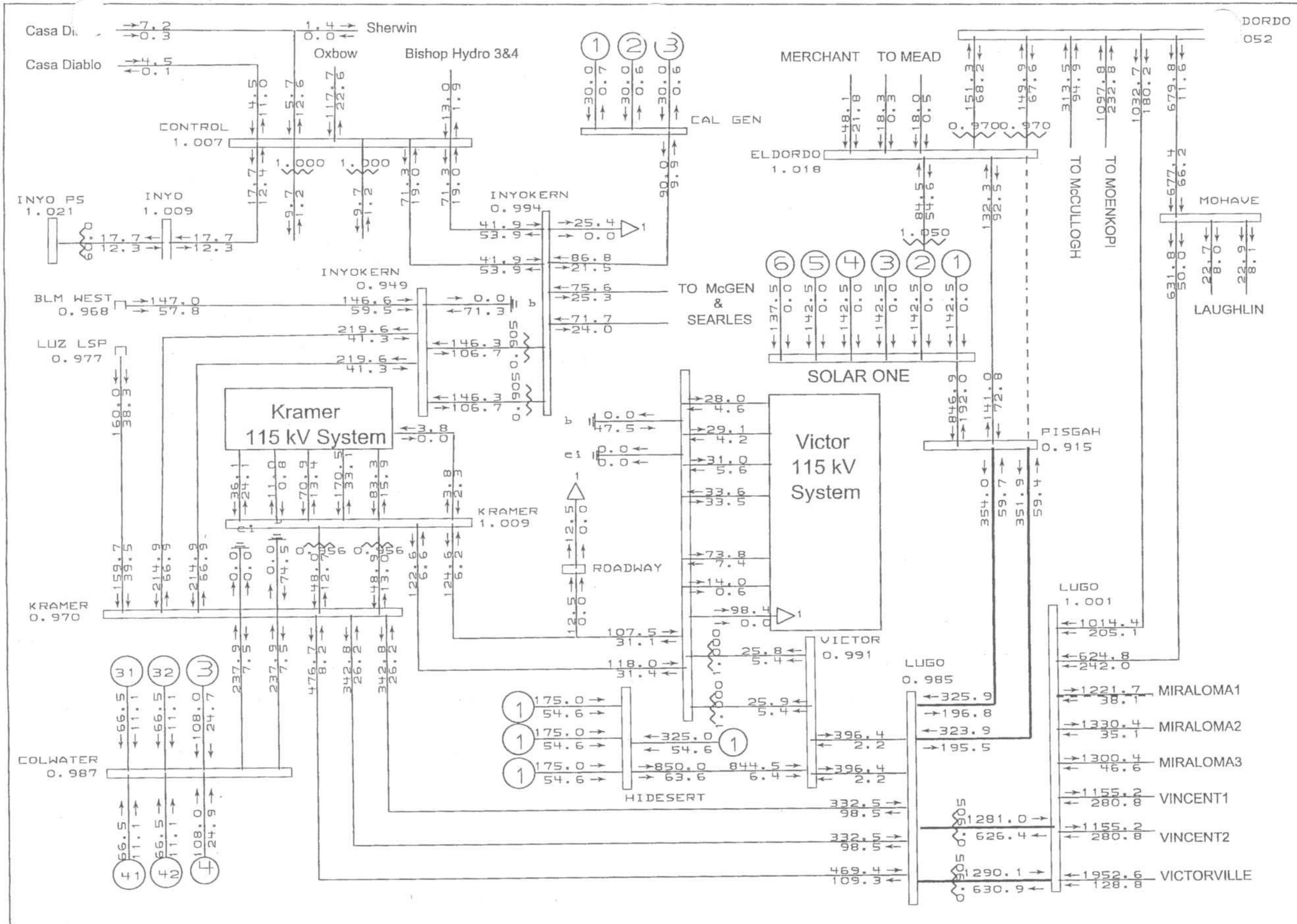
Wed Jan 25 15:32:55 2006

	Solar I System Impact Study: Pre-Project 2009 Spring Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-1: Cima-Eldorado-Pisgah No. 1 230 kV Line	PSLF Program C:\upslf143\MyP Rating =5



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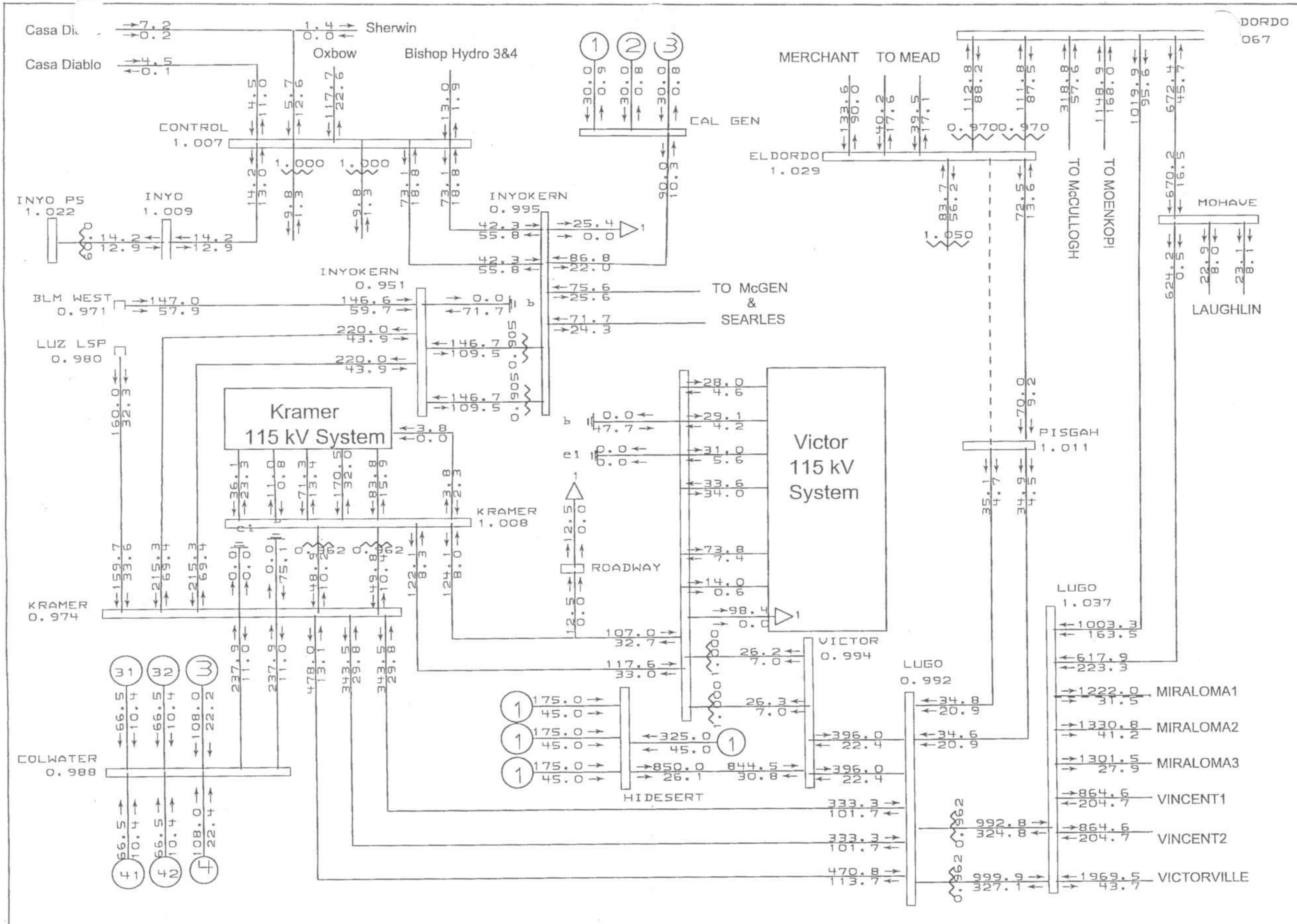
Wed Jan 25 15:34:48 2006

Solar I System Impact Study: Post-Project 2009 Spring Load Conditions Power Flow Case with SES Plant at 850 MW	N-1: Cima-Eldorado-Pisgah No. 1 230 kV Line	PSLF Program C:\upslf143\MyP Rating =5



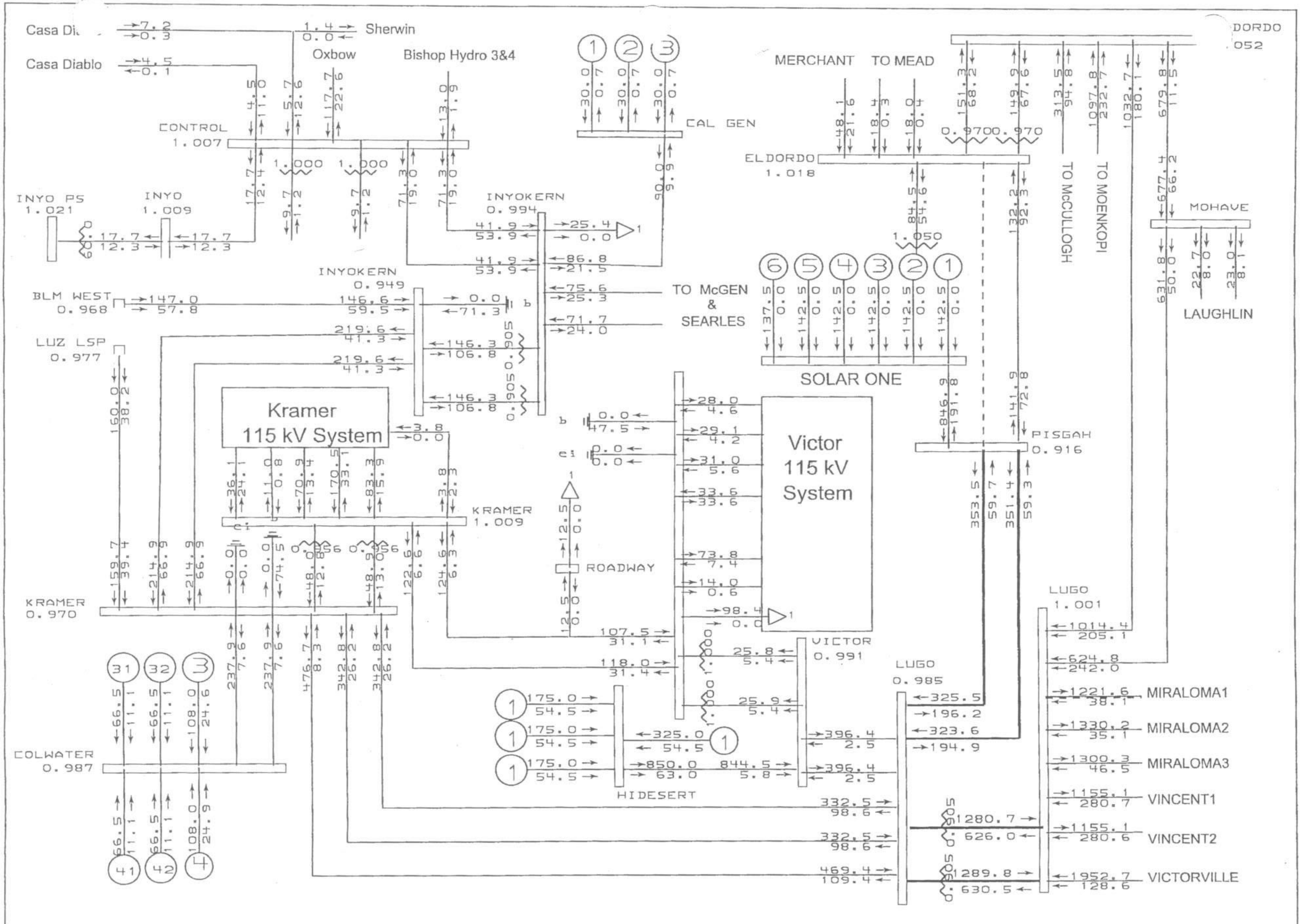
C:\upslf143\MyPSLF\cases_2\1_pre_eld-psgh_2.sav

Wed Jan 25 15:32:59 2006

Solar I System Impact Study: Pre-Project
2009 Spring Load Conditions
Power Flow Case with Significant Pre-Proj Upgrades

N-1: Eldorado-Pisgah No. 2 230 kV Line

PSLF Program
C:\upslf143\MyP
Rating =5



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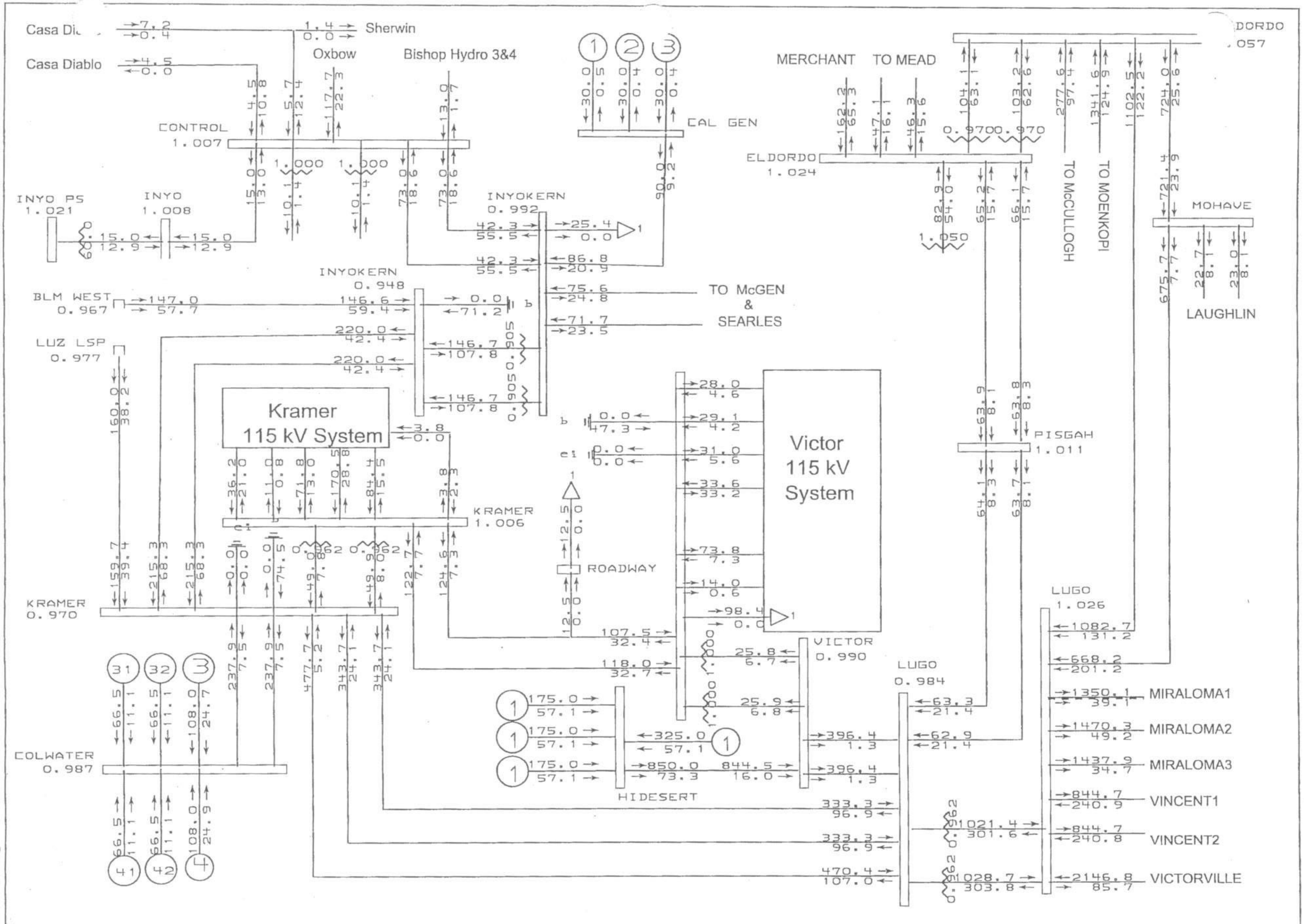
Wed Jan 25 15:34:55 2006

Solar I System Impact Study: Post-Project 2009 Spring Load Conditions Power Flow Case with SES Plant at 850 MW	N-1: Eldorado-Pisgah No. 2 230 kV Line	PSLF Program C:\upslf143\MyP Rating =5



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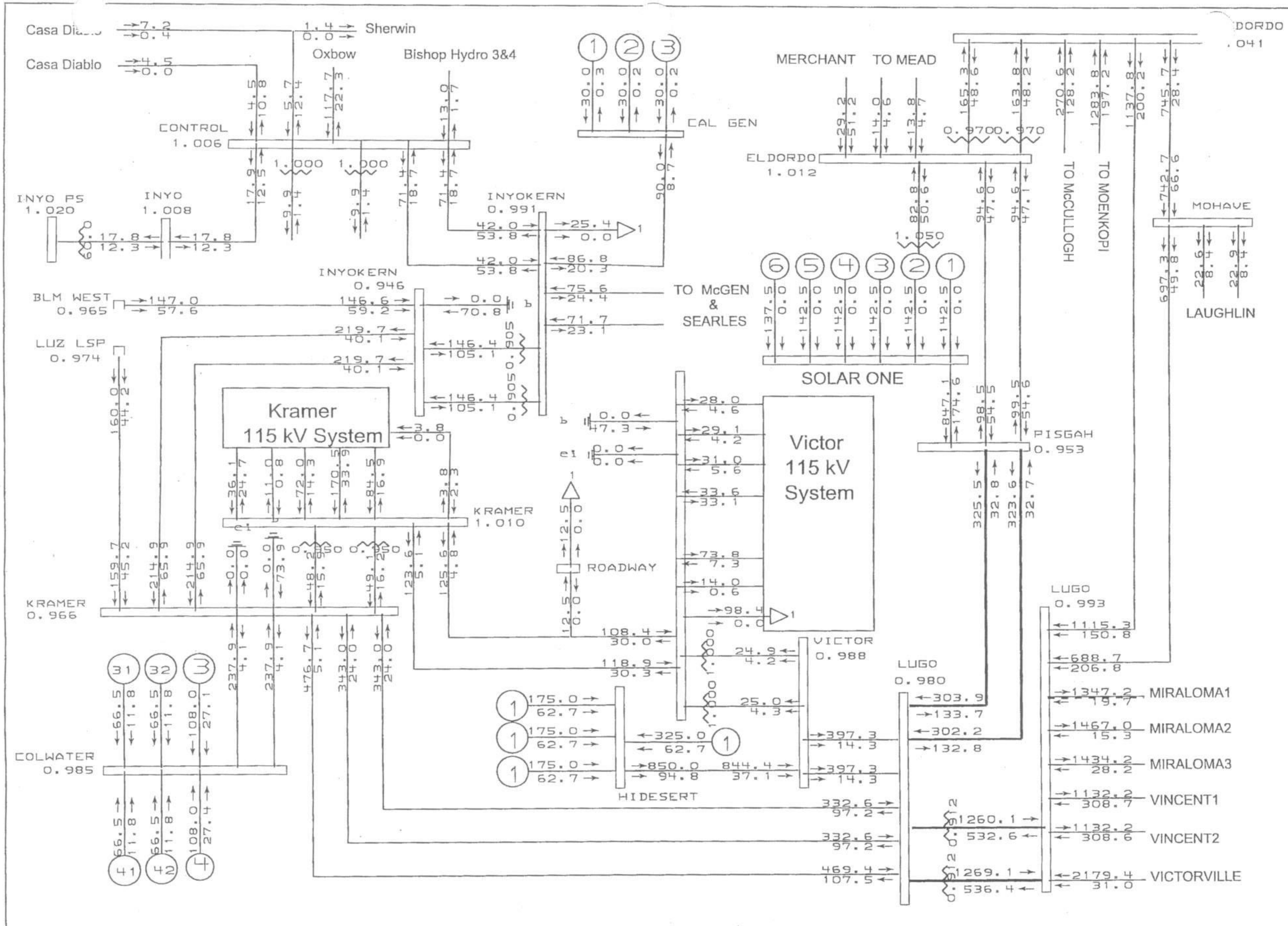
Wed Jan 25 15:32:50 2006

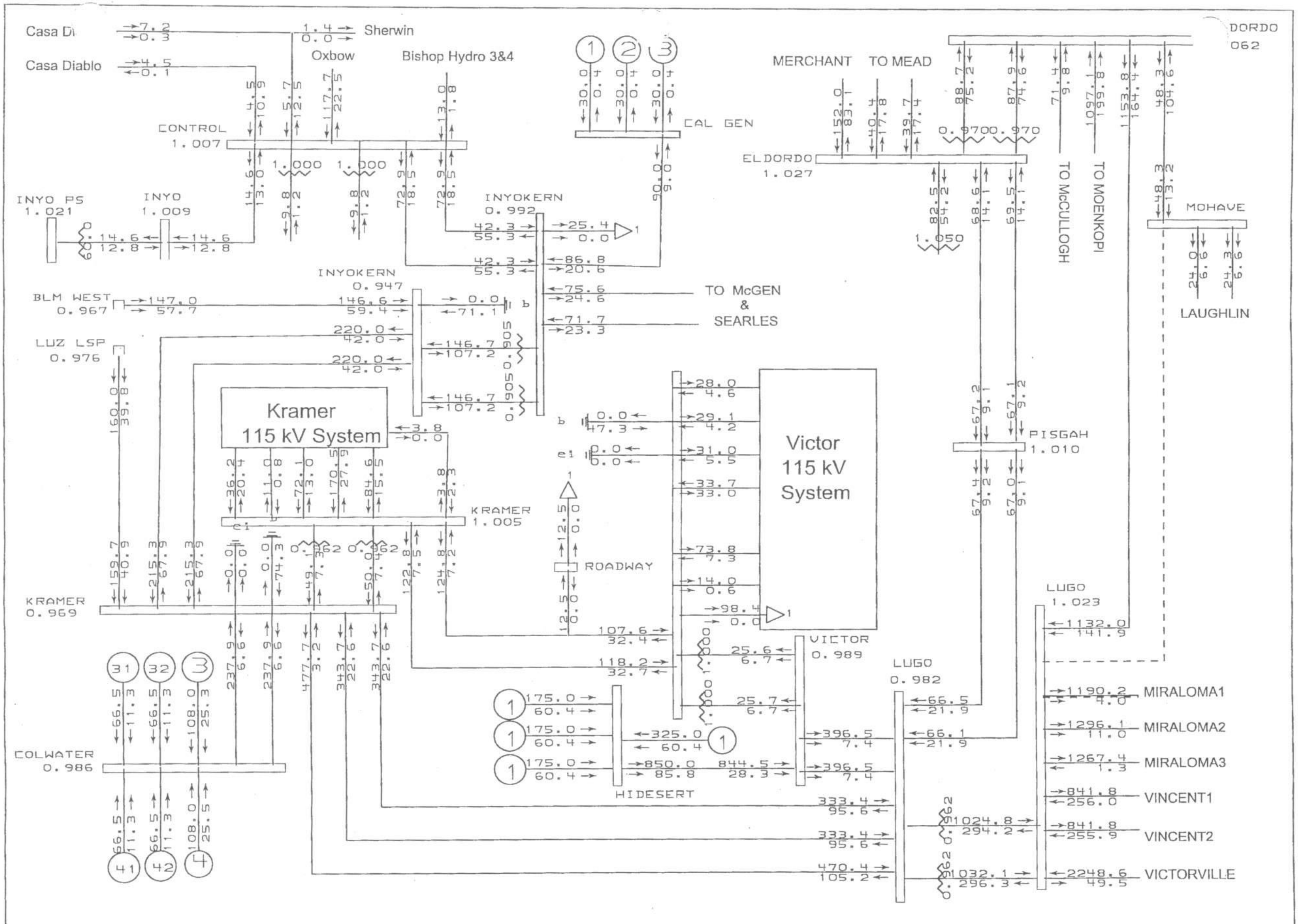
Solar I System Impact Study: Pre-Project 2009 Spring Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-1: Devers-Palo Verde 500 kV Line	PSLF Program C:\upslf143\MyP Rating =5



C:\upslf143\MyPSLF\cases_2\1_pst_dvrs-p_vrde.sav

Wed Jan 25 15:34:42 2006

Solar I System Impact Study: Post-Project 2009 Spring Load Conditions Power Flow Case with SES Plant at 850 MW	N-1: Devers-Palo Verde 500 kV Line	PSLF Program C:\upslf143\MyP Rating =5



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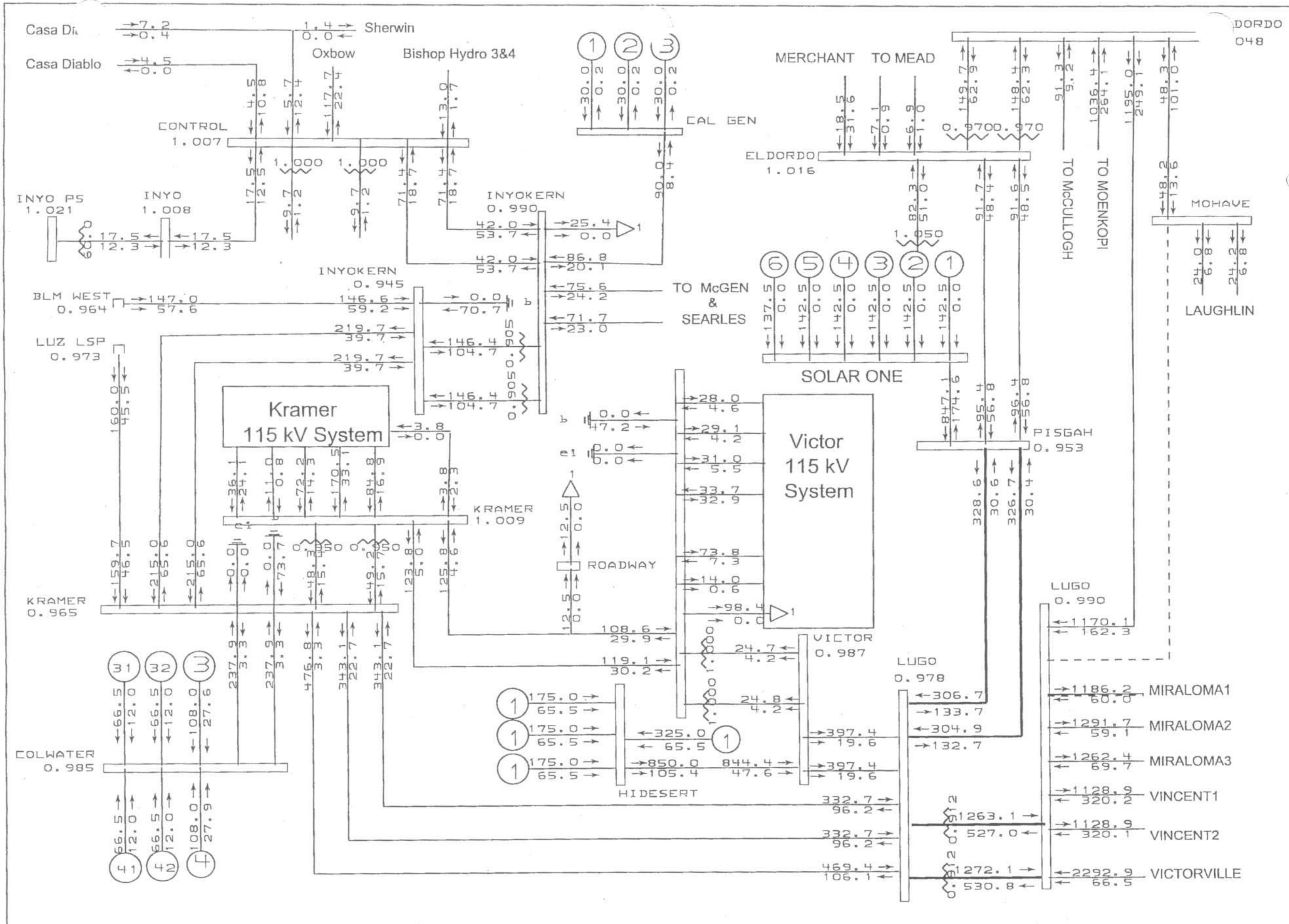
Wed Jan 25 15:32:42 2006

	Solar I System Impact Study: Pre-Project 2009 Spring Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-1: Lugo-Mohave 500 kV Line	PSLF Program C:\upslf143\MyP Rating =5



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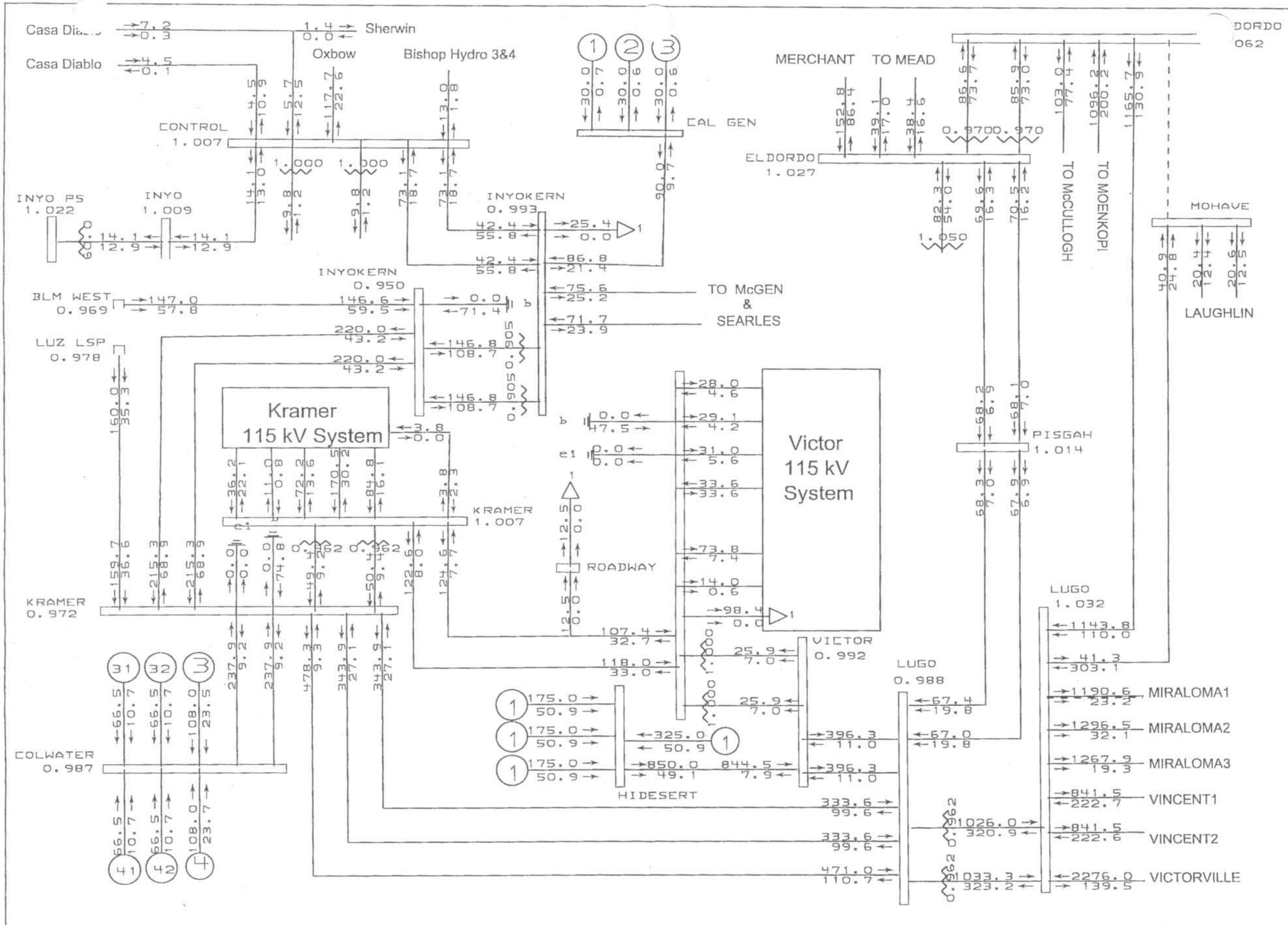
Wed Jan 25 15:34:27 2006

	Solar I System Impact Study: Post-Project 2009 Spring Load Conditions Power Flow Case with SES Plant at 850 MW	N-1: Lugo-Mohave 500 kV Line	PSLF Program C:\upslf143\MyP Rating =5



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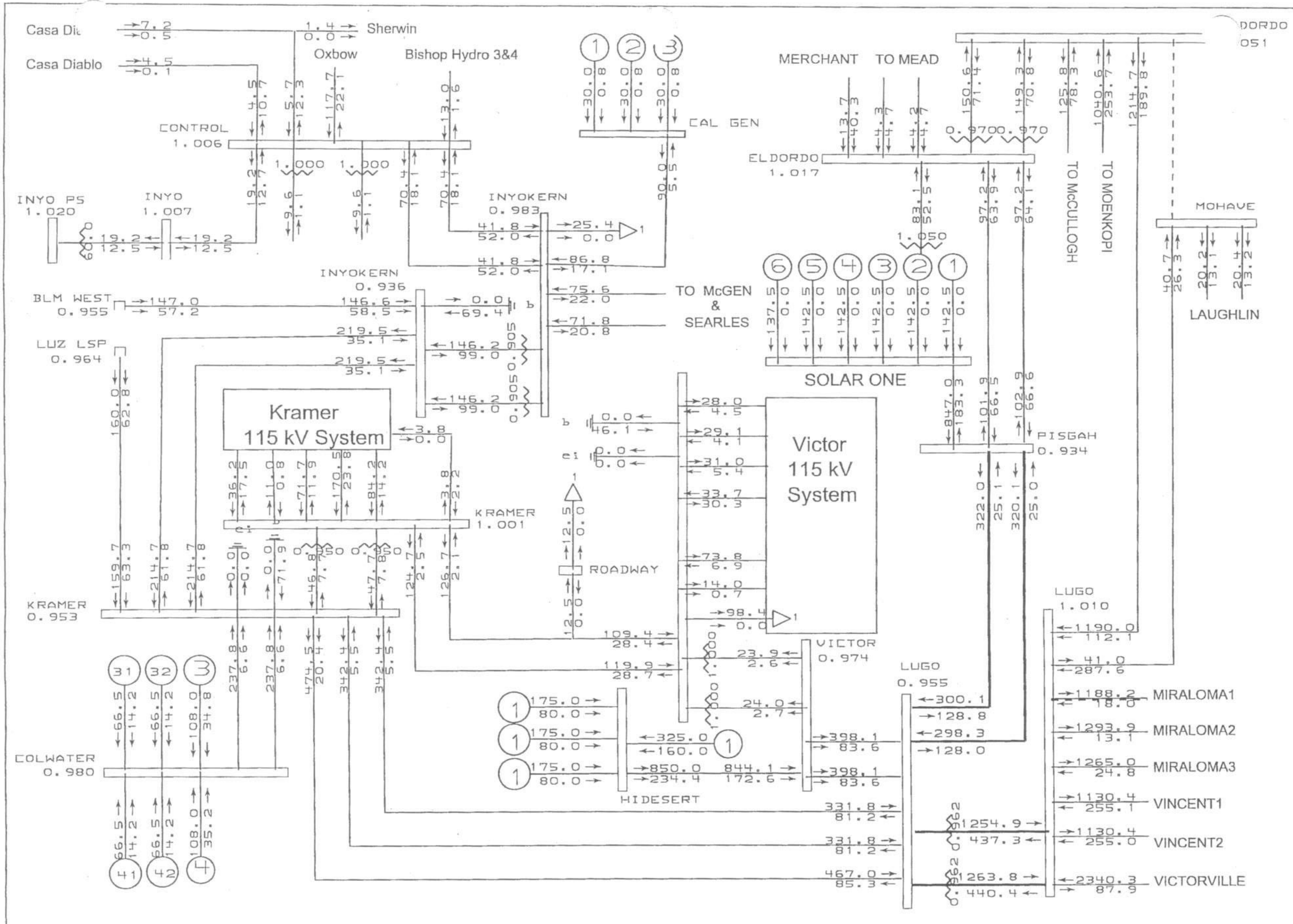
Wed Jan 25 15:32:39 2006

Solar I System Impact Study: Pre-Project 2009 Spring Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-1: Eldorado-Mohave 500 kV Line	PSLF Program C:\upslf143\MyP Rating =5



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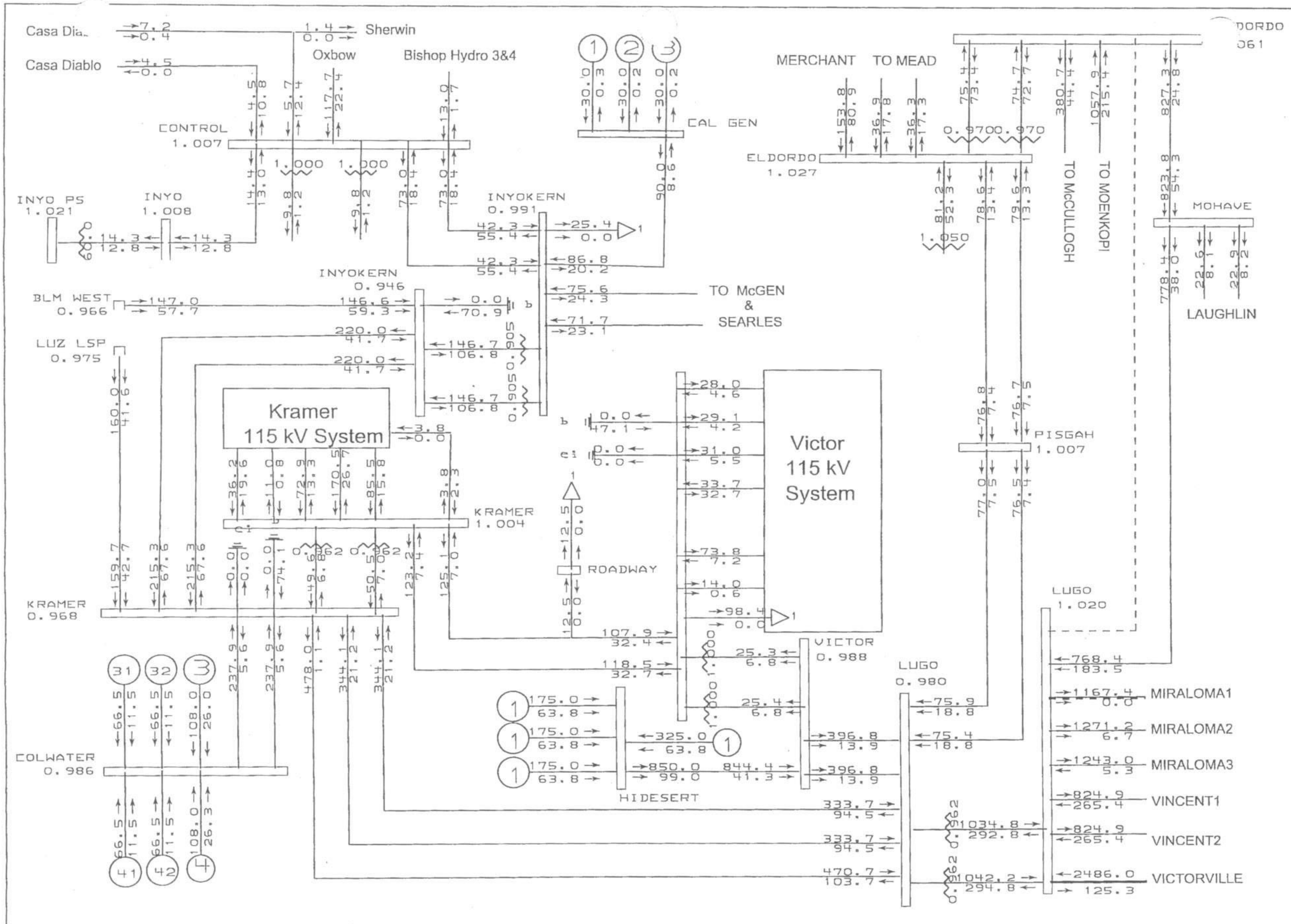
Wed Jan 25 15:34:21 2006

	Solar I System Impact Study: Post-Project 2009 Spring Load Conditions Power Flow Case with SES Plant at 850 MW	N-1: Eldorado-Mohave 500 kV Line	PSLF Program C:\upslf143\MyP Rating =5



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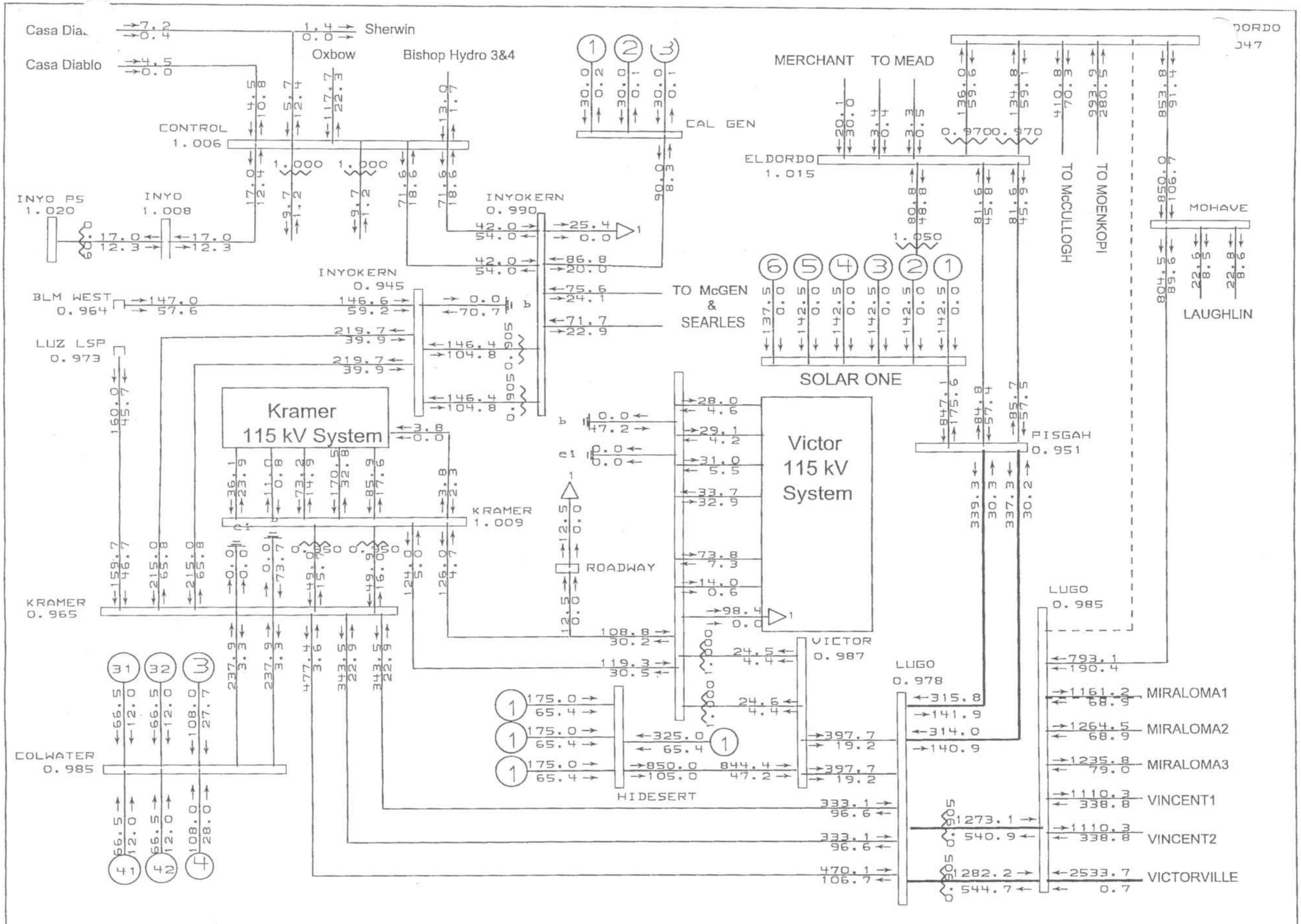

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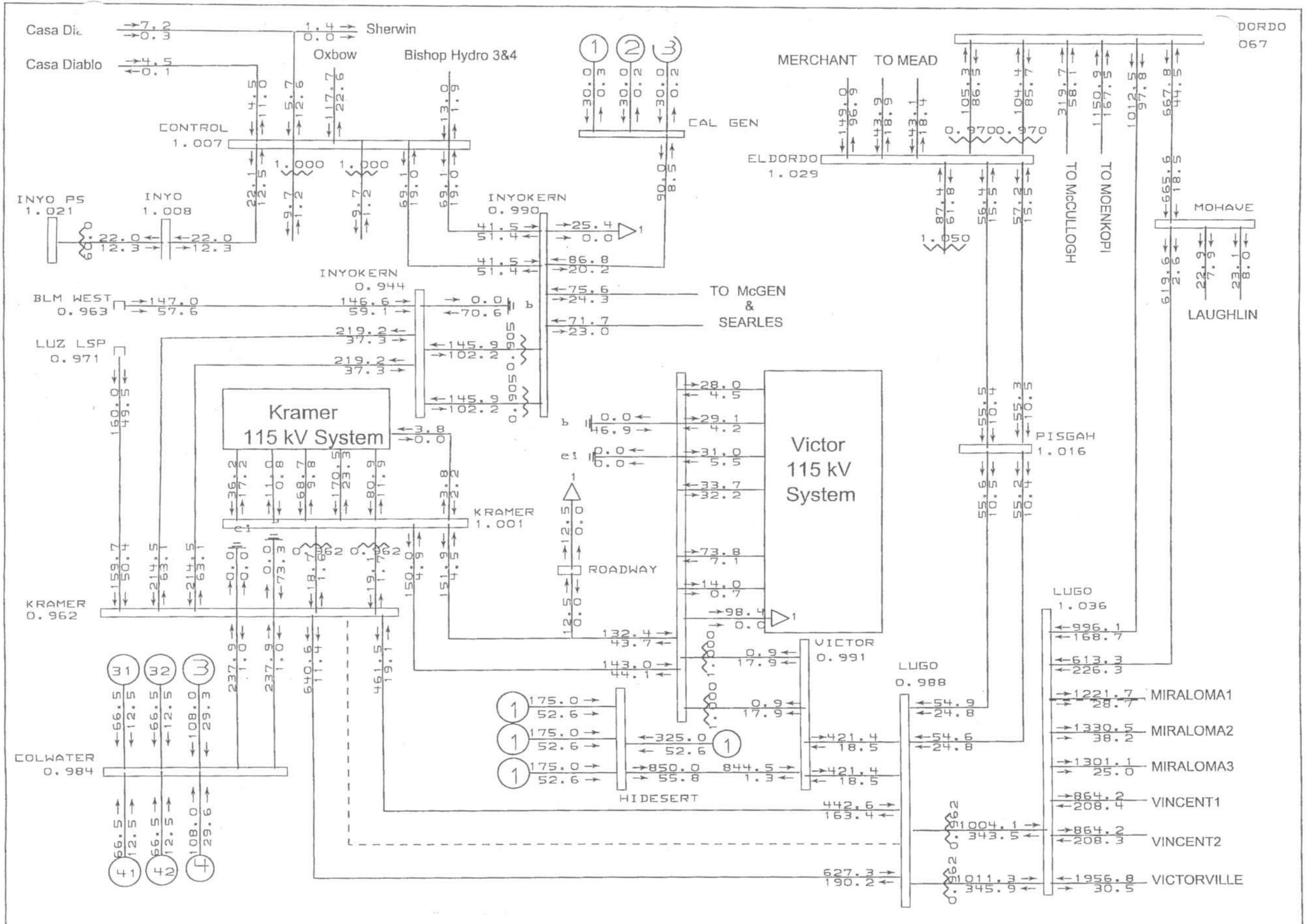

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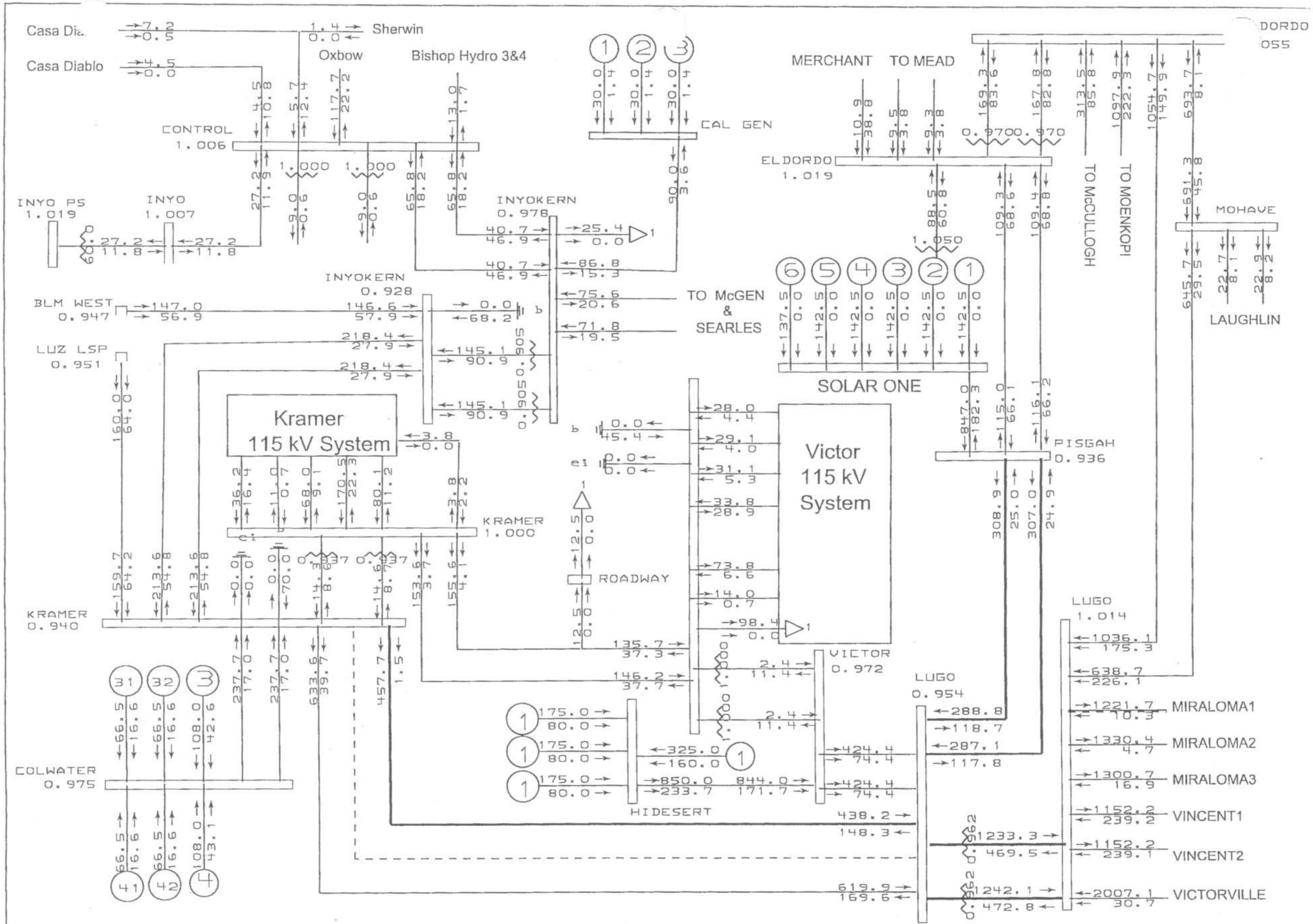

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Wed Jan 25 15:35:03 2006

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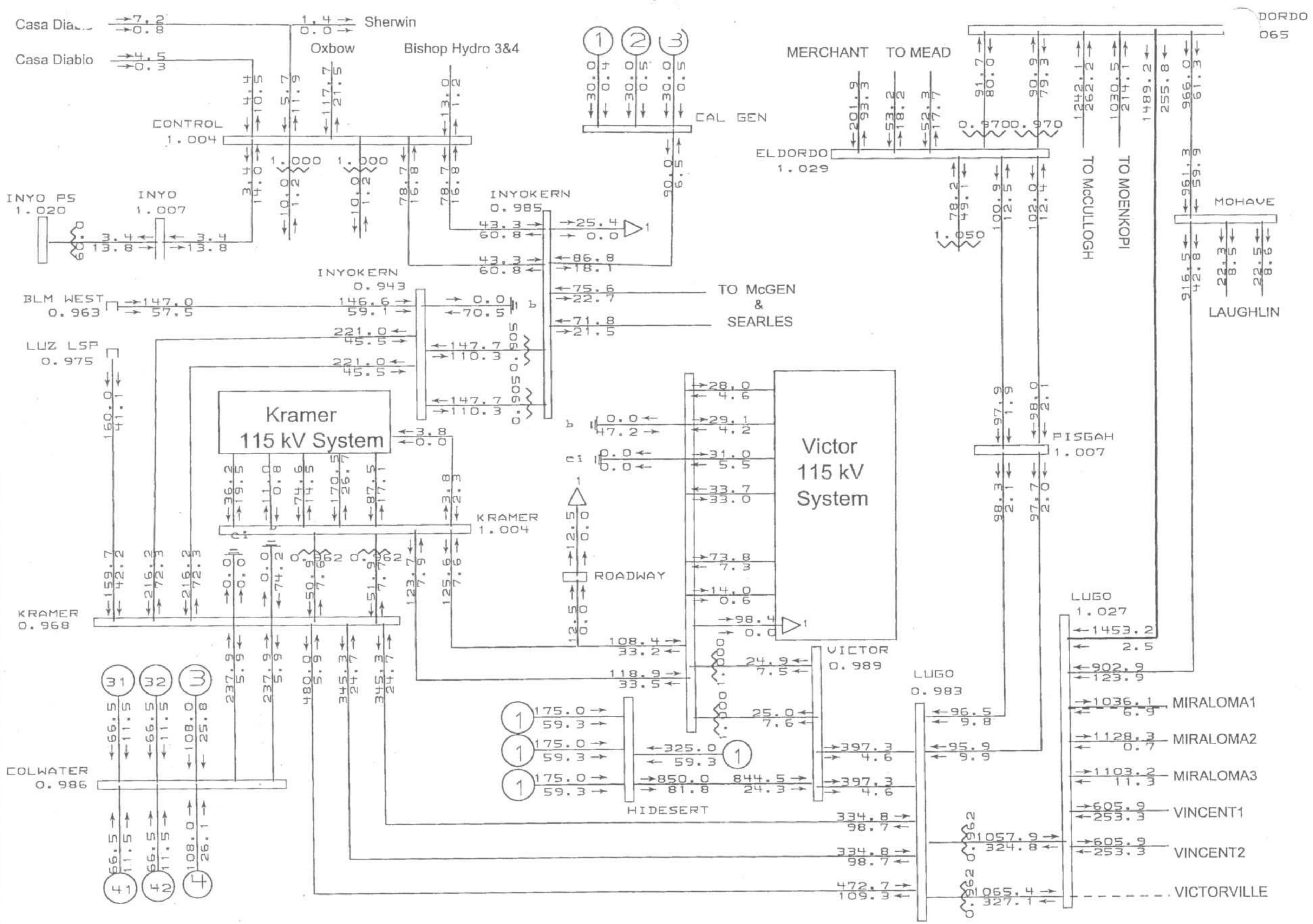

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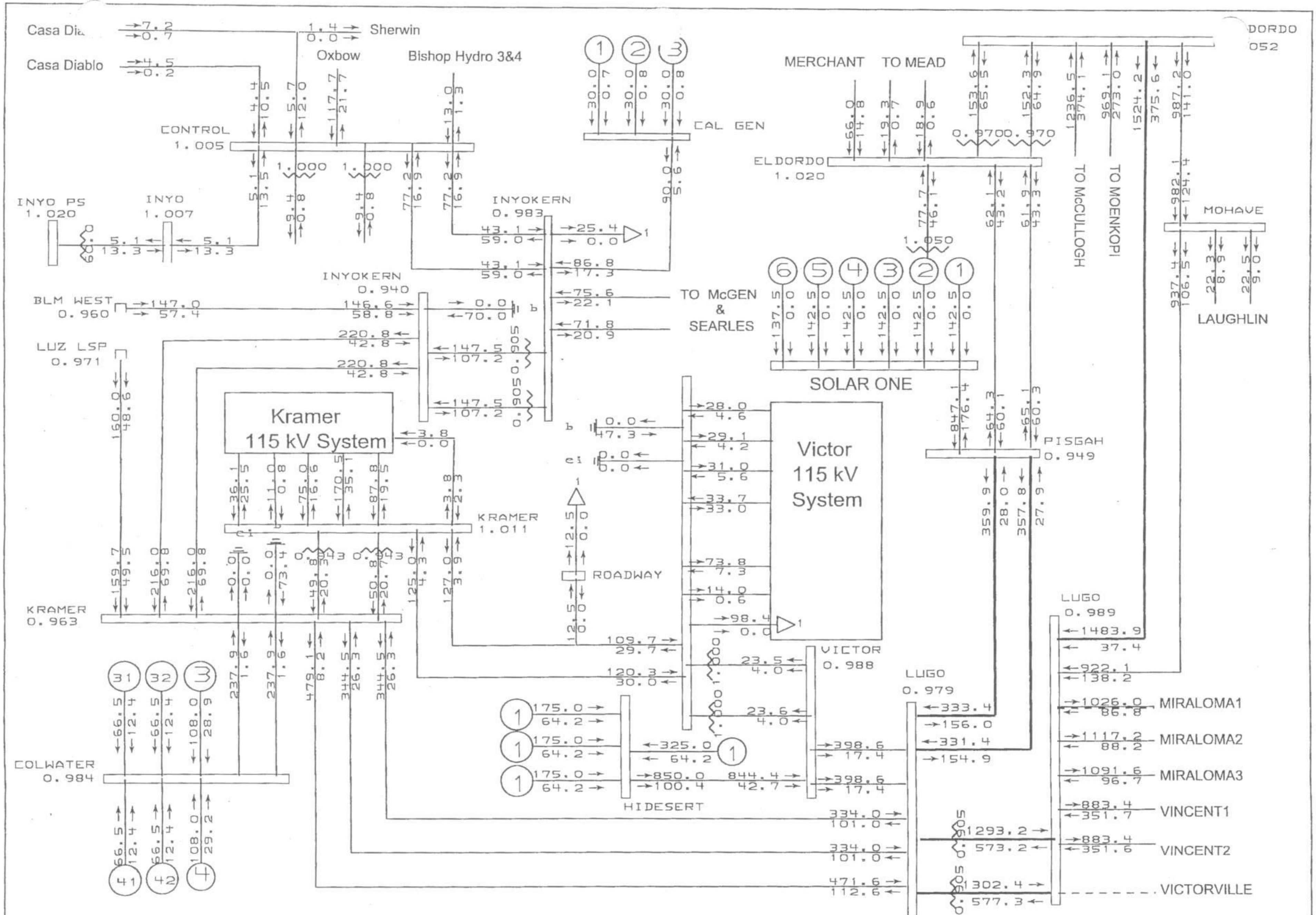
Wed Jan 25 15:32:46 2006

Solar I System Impact Study: Pre-Project
2009 Spring Load Conditions
Power Flow Case with Significant Pre-Proj Upgrades

N-1: Lugo-Victorville 500 kV Line

PSLF Program
C:\upslf143\MyP
Rating =5



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Wed Jan 25 15:34:34 2006

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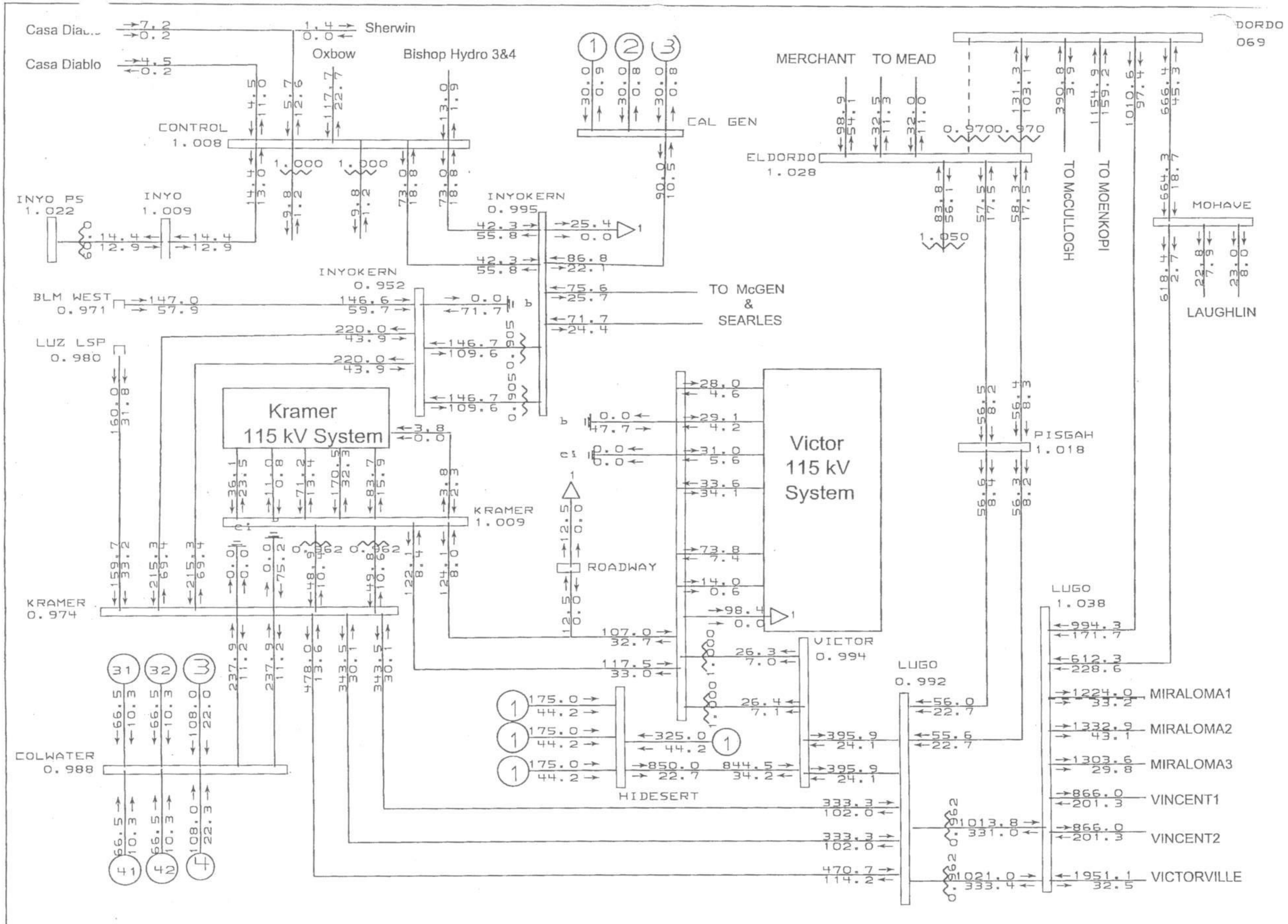

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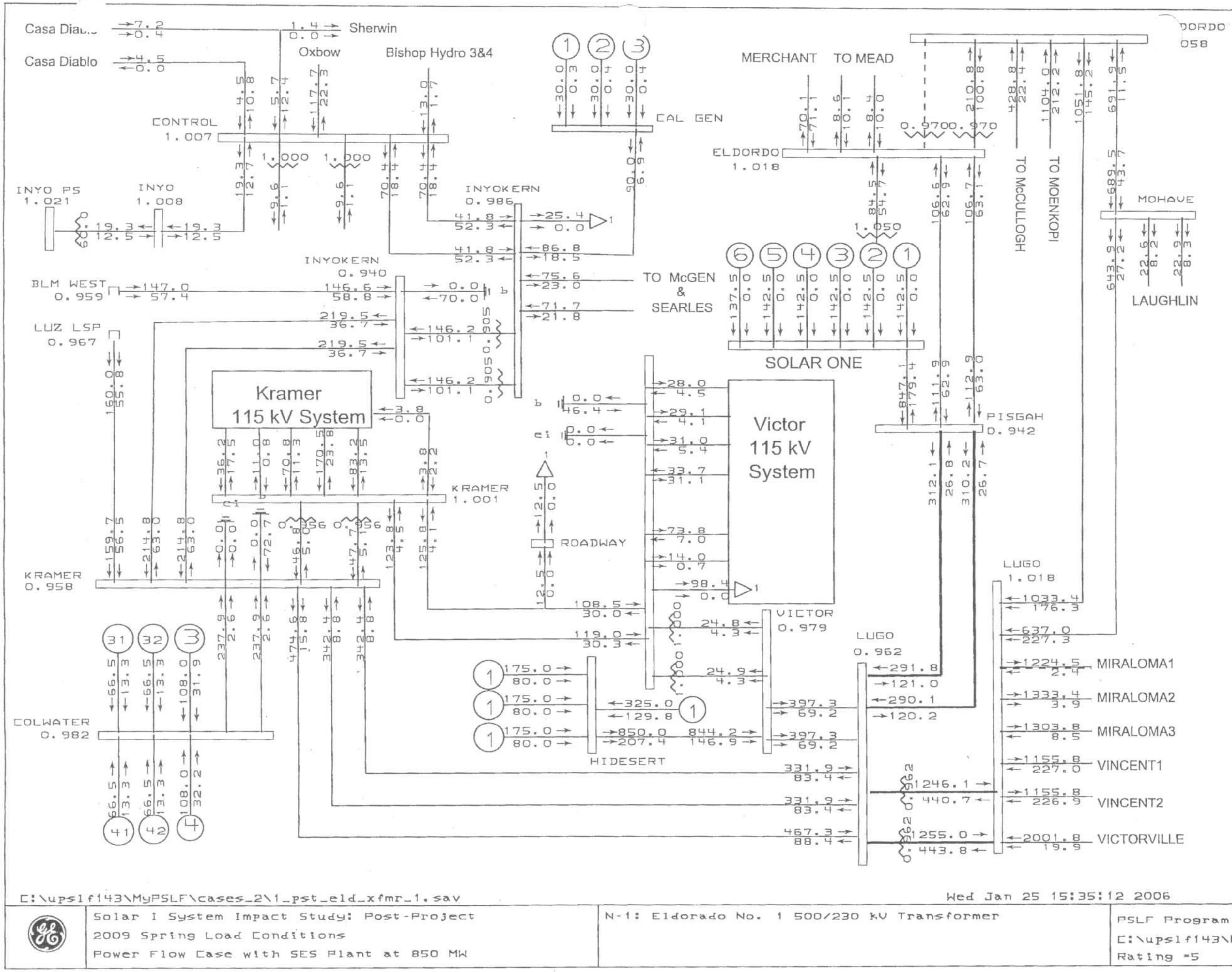
Wed Jan 25 15:33:12 2006

GE	Solar I System Impact Study: Pre-Project 2009 Spring Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-1: Eldorado No. 1 500/230 kV Transformer	PSLF Program C:\upslf143\MyP Rating =5



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Oxbow
Bishop Hydro 3&4
CONTROL 1.007
INYO PS 1.021
INYO 1.008
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BLM WEST 0.959
LUZ LSP 0.967
CAL GEN
MERCHANT
TO MEAD
ELDORDO 1.018
TO McCULLOGH
TO MOENKOPI
MOHAVE
LAUGHLIN
TO McGEN & SEARLES
SOLAR ONE
Kramer 115 kV System
KRAMER 1.001
KRAMER 0.958
COLWATER 0.982
ROADWAY
Victor 115 kV System
VICTOR 0.979
HIDESERT
PISGAH 0.942
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MIRALOMA1
MIRALOMA2
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2009 Spring Load Conditions
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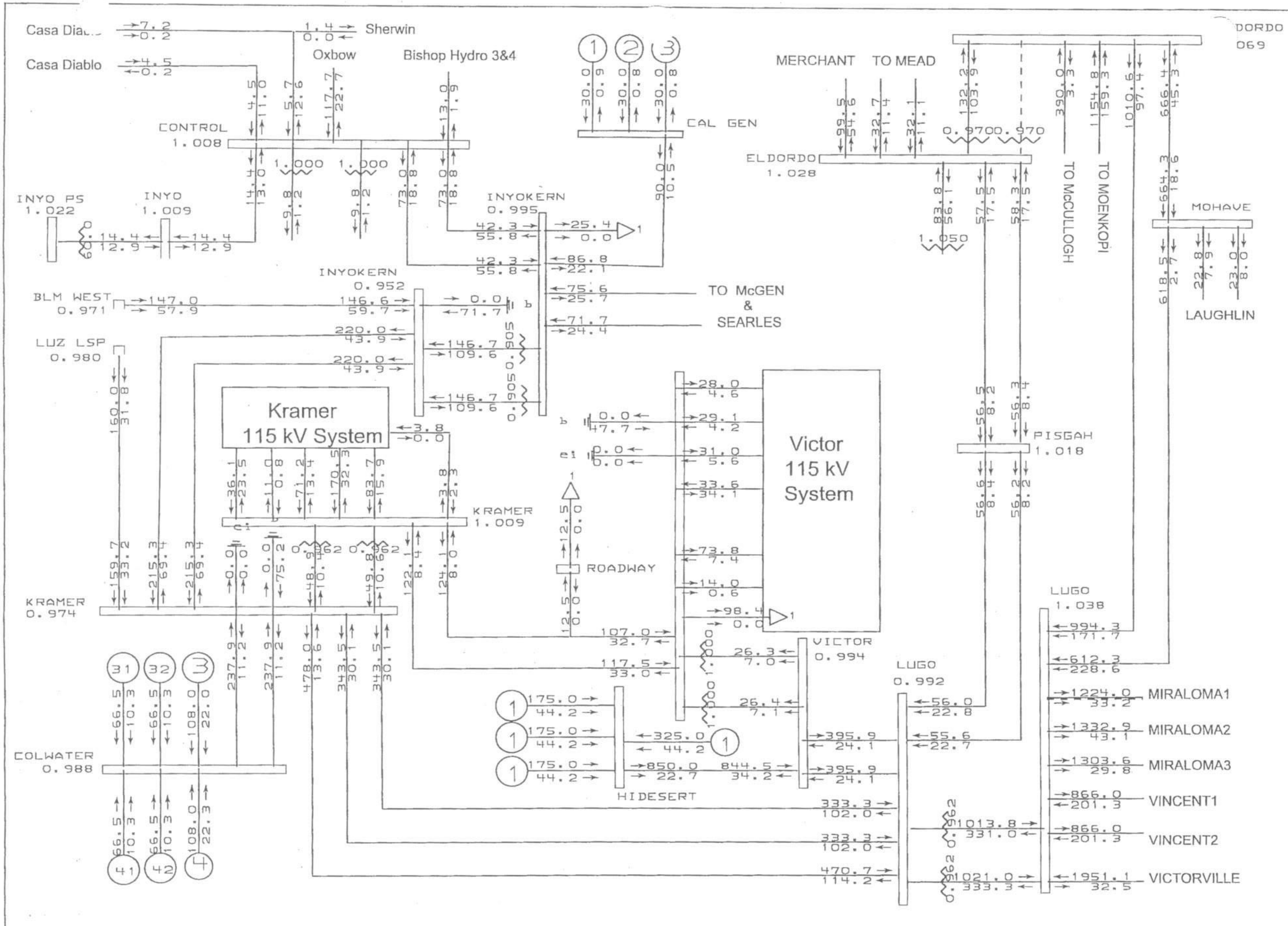

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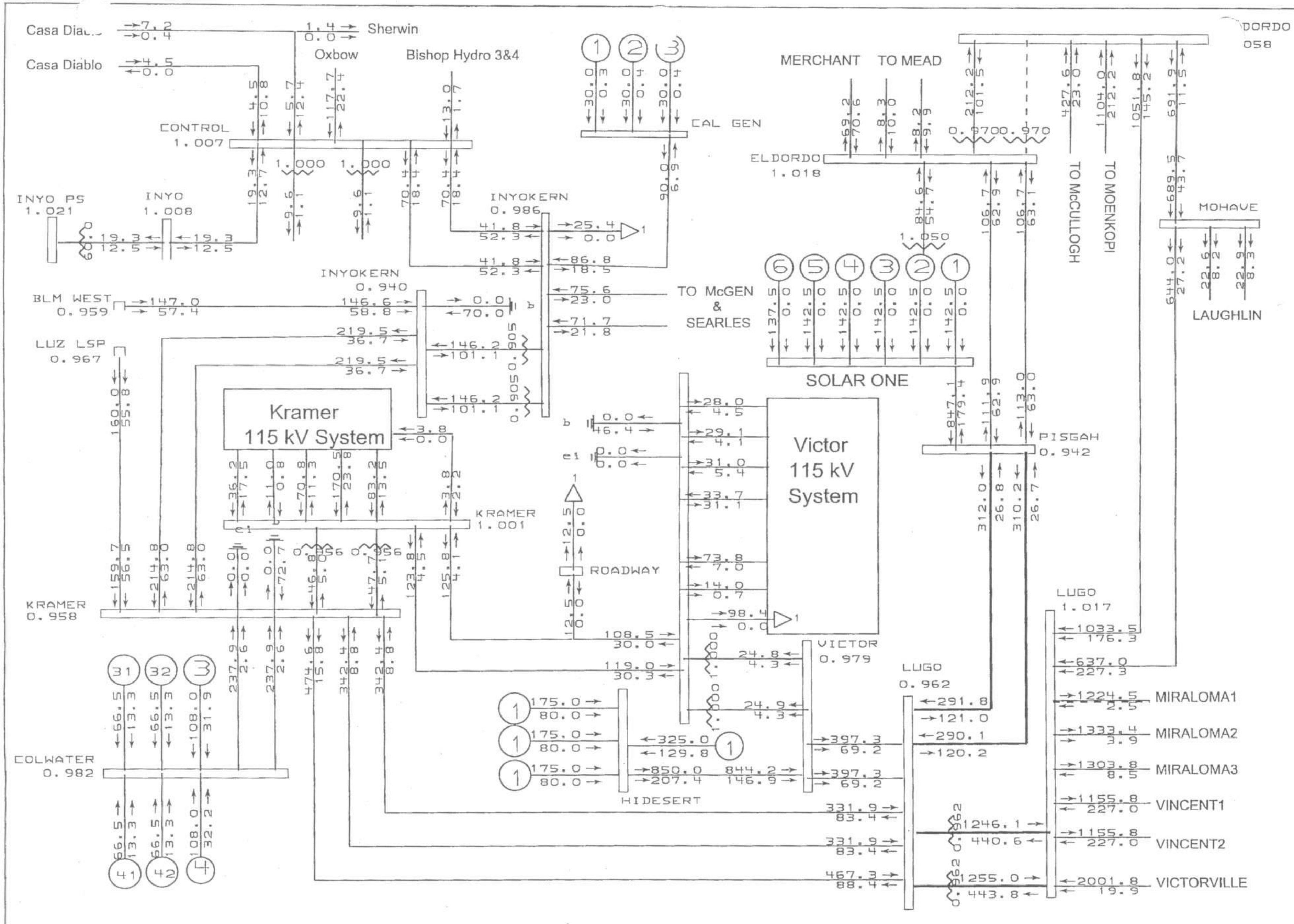

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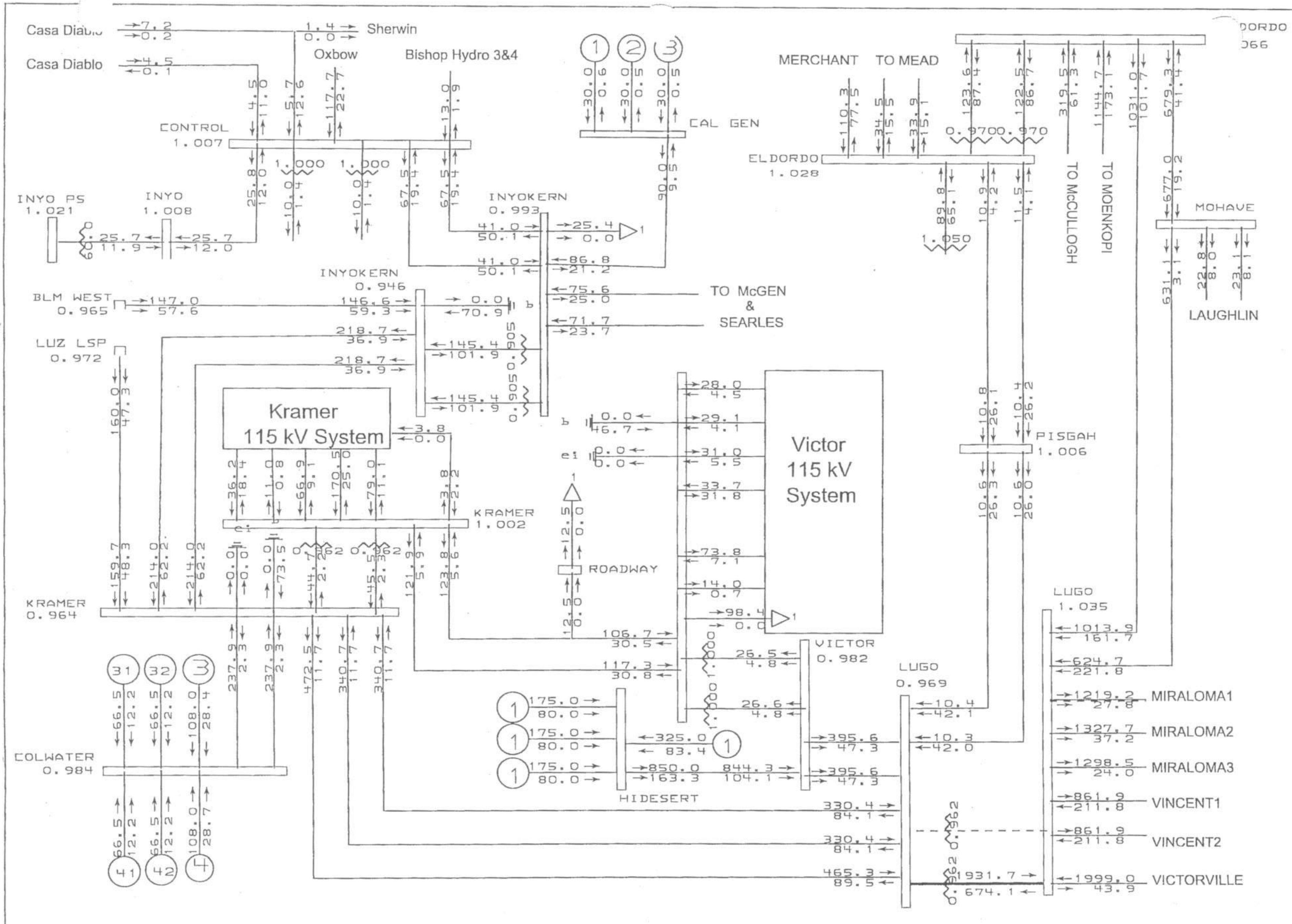

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Wed Jan 25 15:33:22 2006

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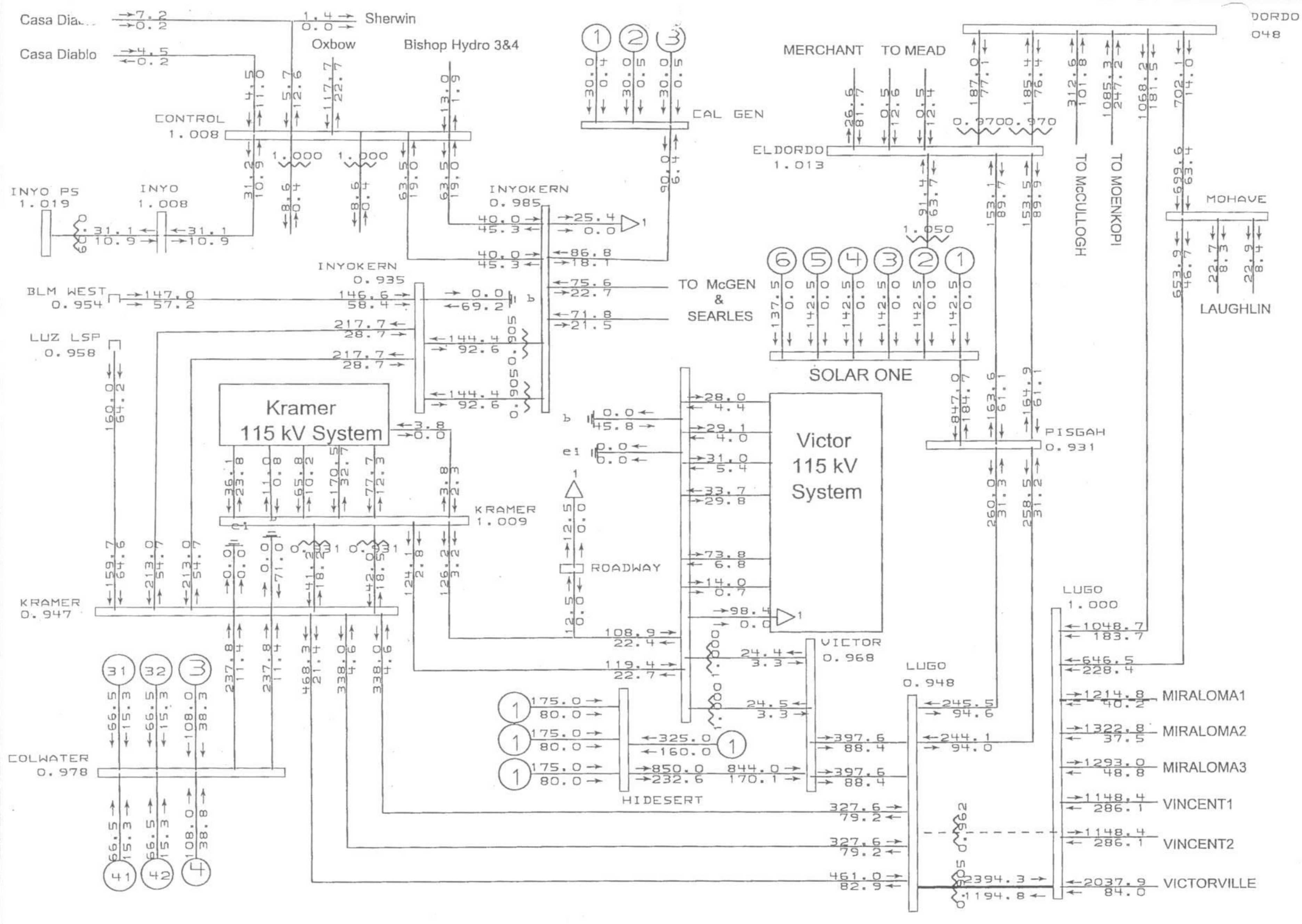

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Wed Jan 25 15:35:22 2006

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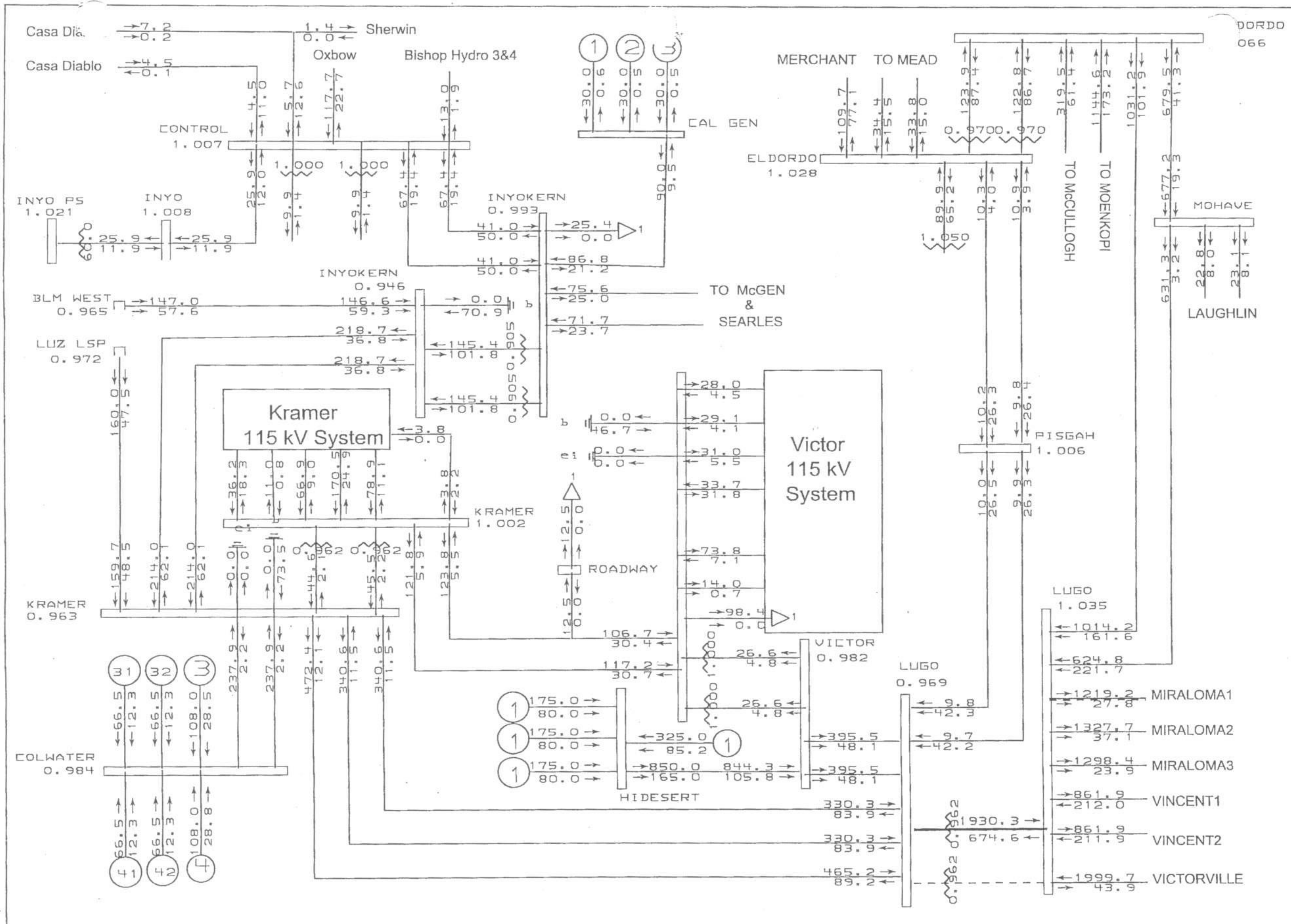

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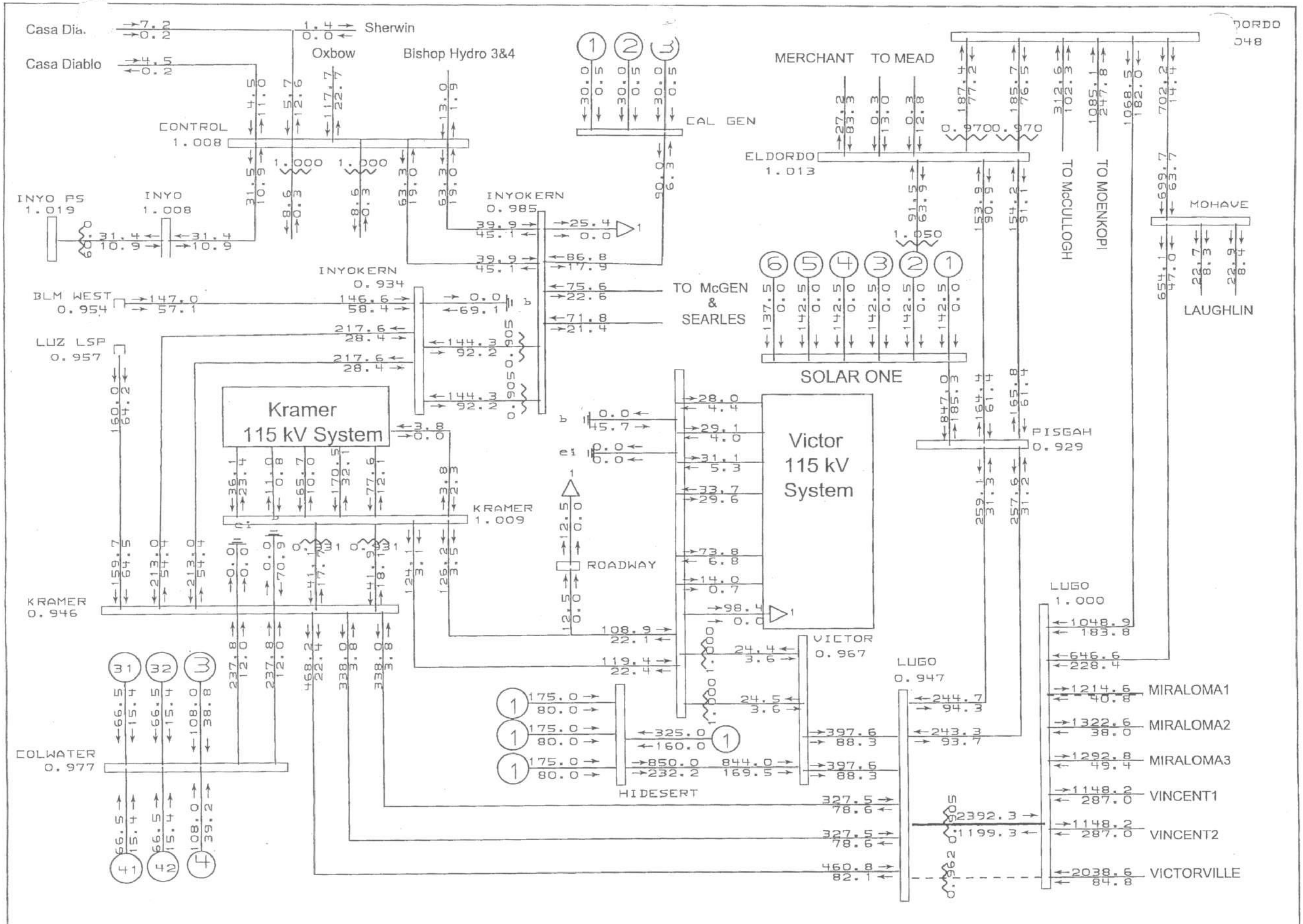

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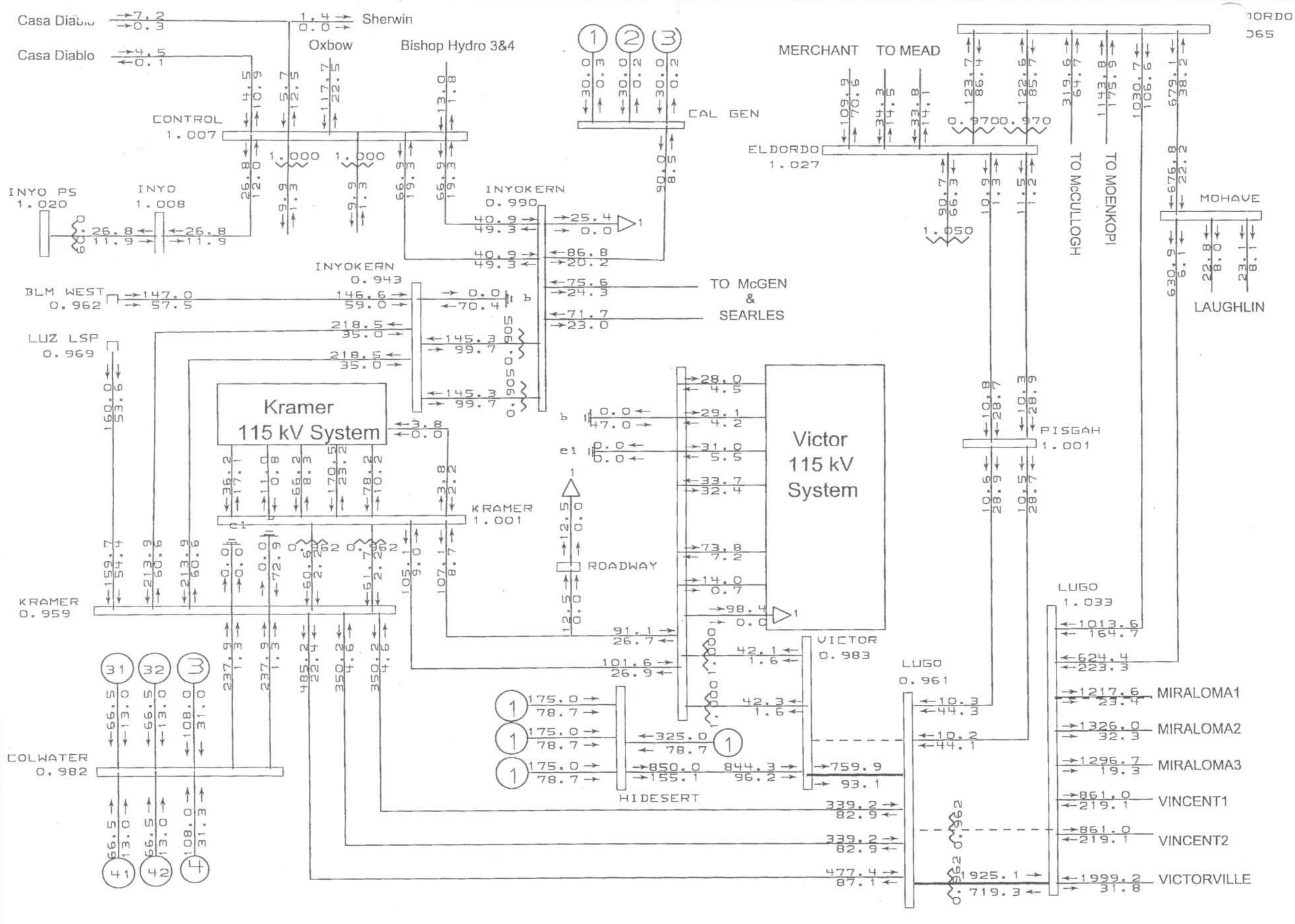

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Wed Jan 25 15:34:06 2006

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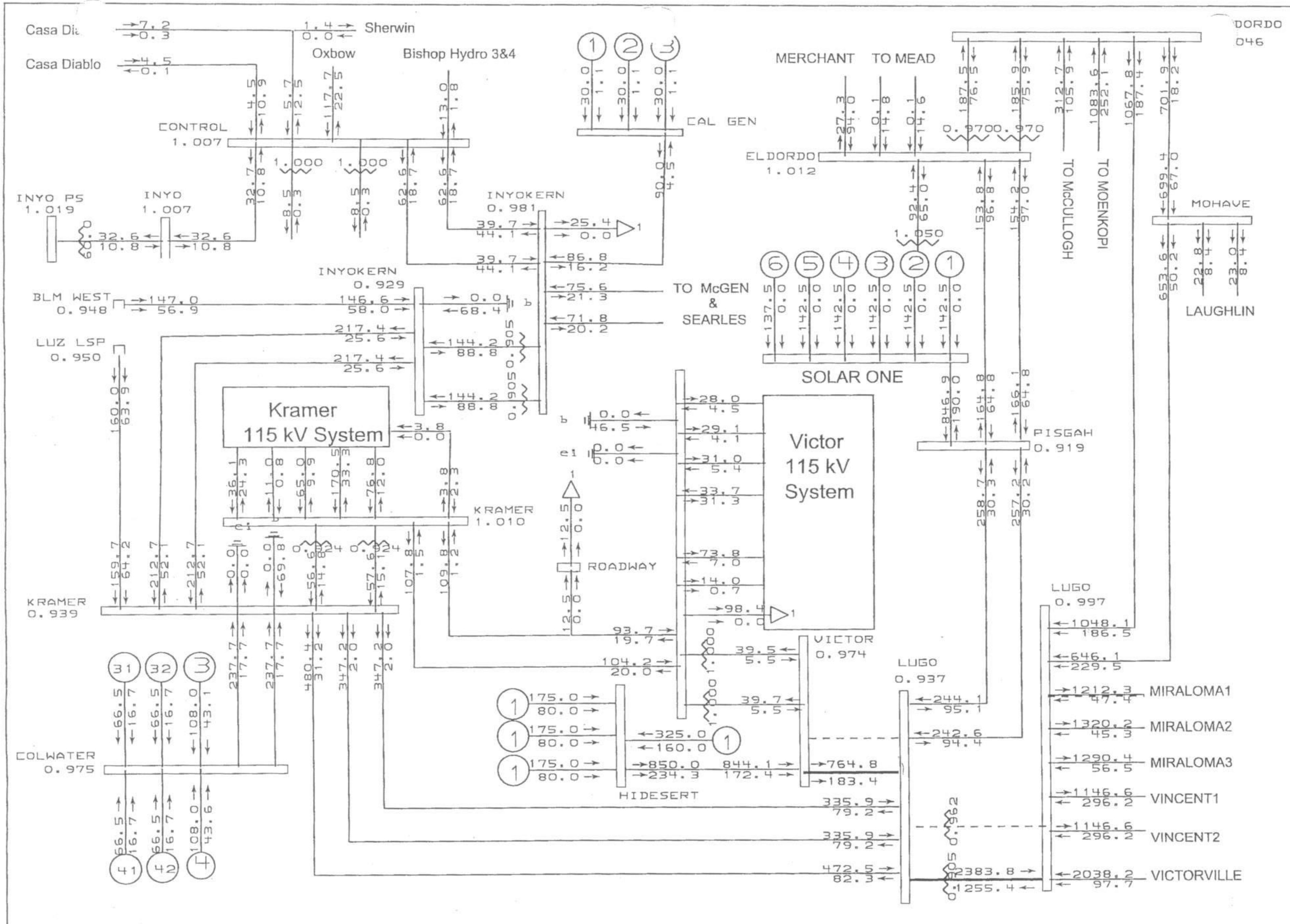

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Wed Jan 25 15:36:08 2006

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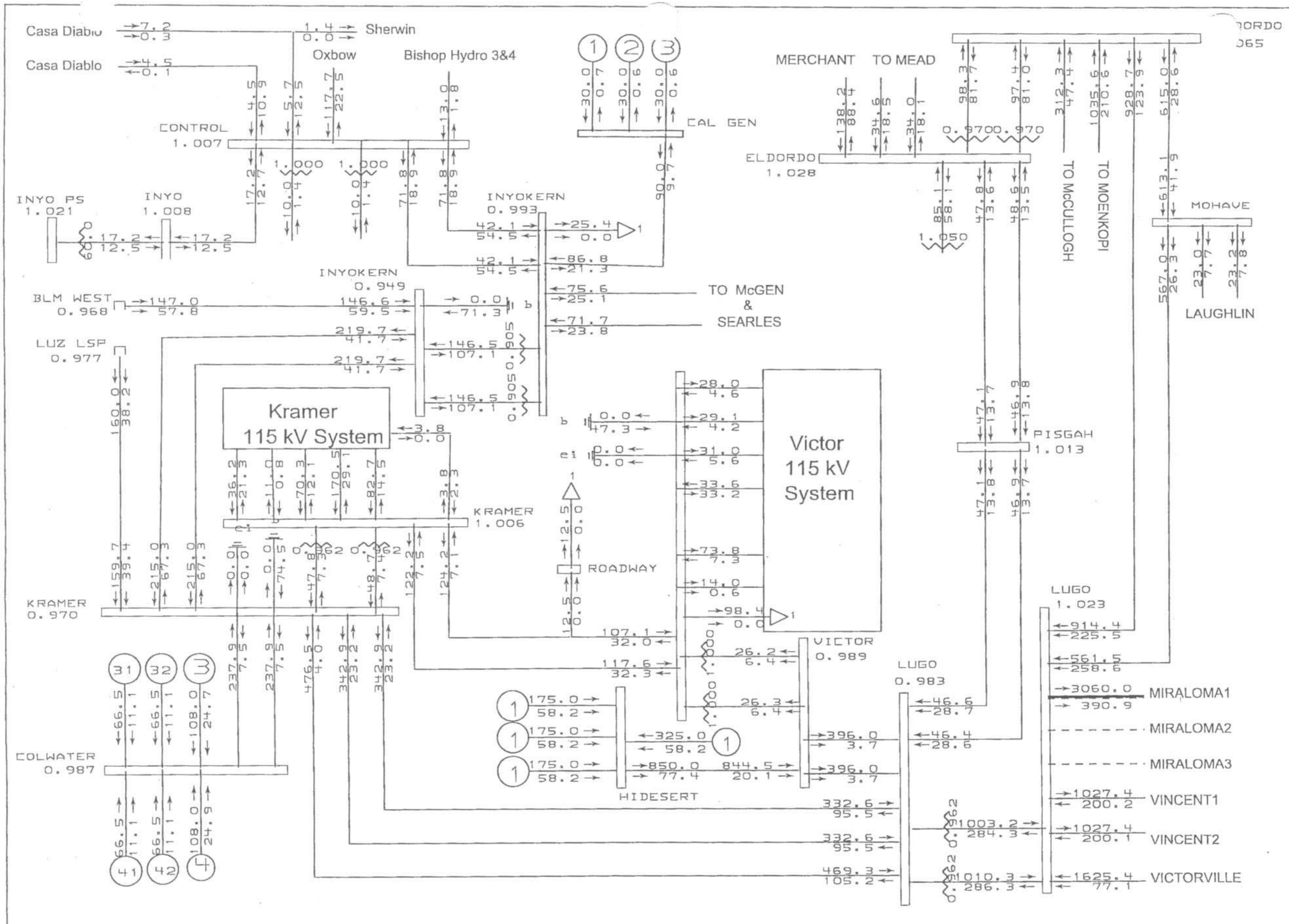

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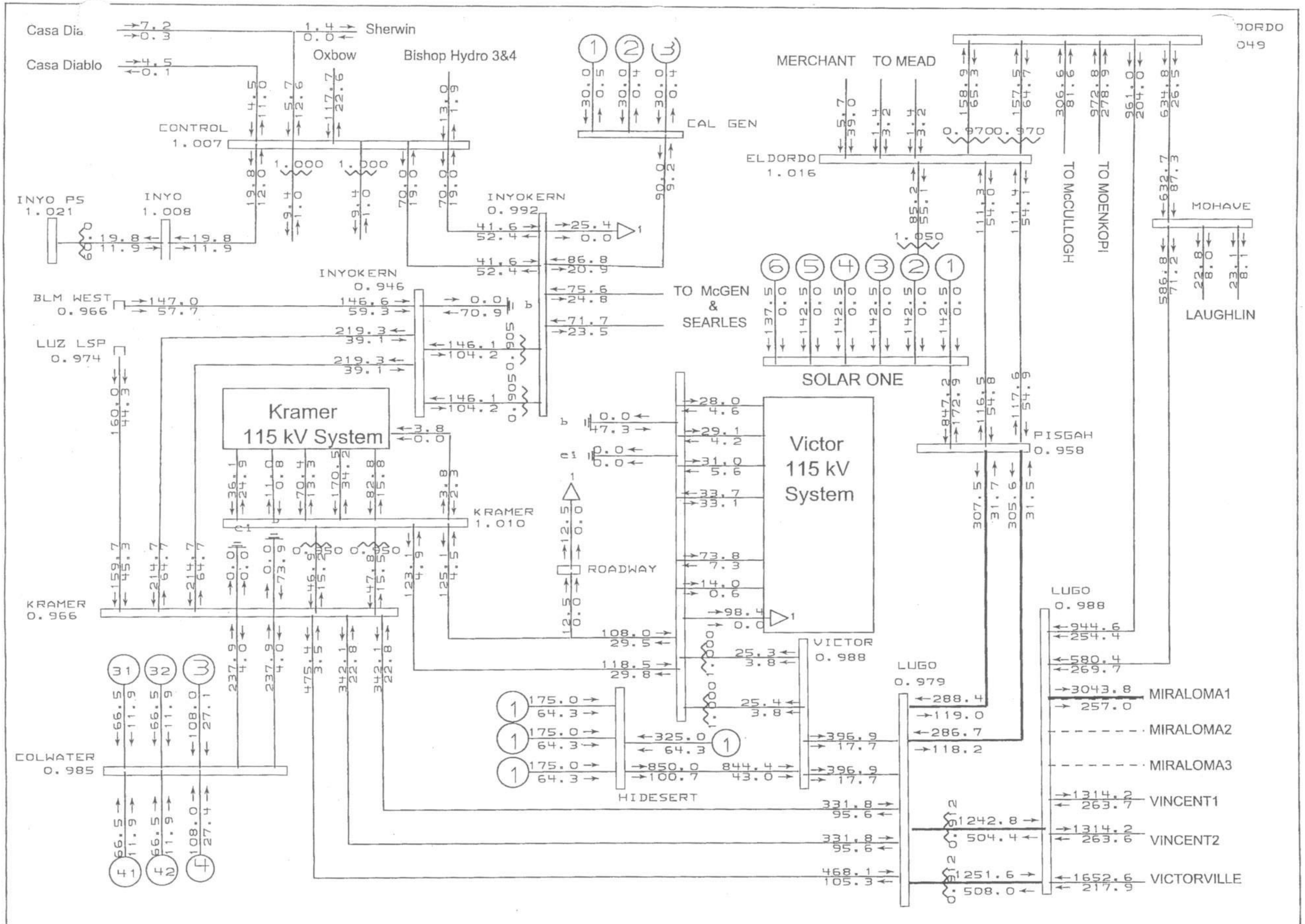

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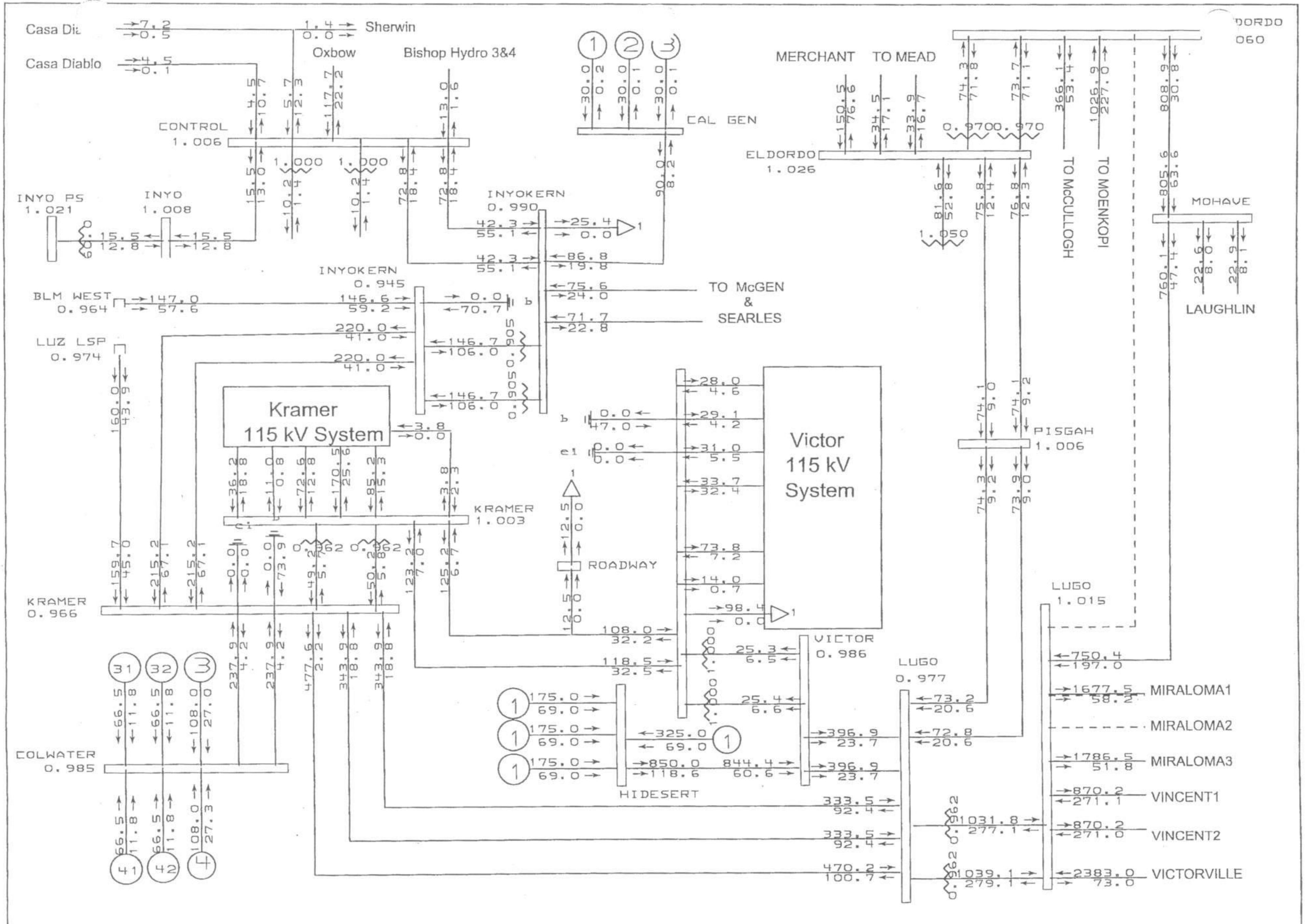
Wed Jan 25 15:35:32 2006

GE	Solar I System Impact Study: Post-Project 2009 Spring Load Conditions Power Flow Case with SES Plant at 850 MW	N-2: Lugo-Mira Loma No. 2 500 kV Line and Lugo-Mira Loma No. 3 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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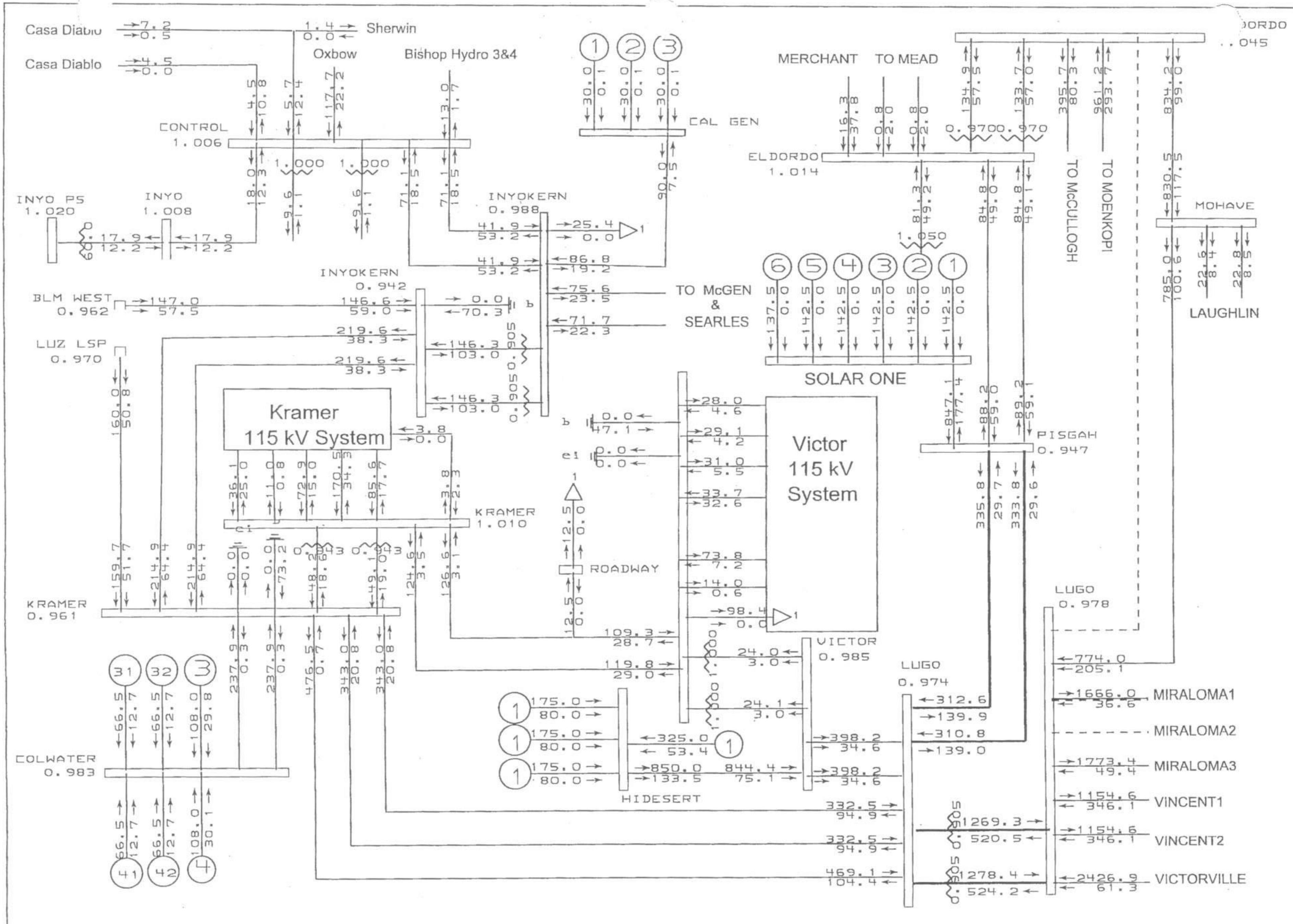
Wed Jan 25 15:33:39 2006

GE	Solar I System Impact Study: Pre-Project 2009 Spring Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-2: Lugo-Mira Loma No. 2 500 kV Line and Eldorado-Lugo 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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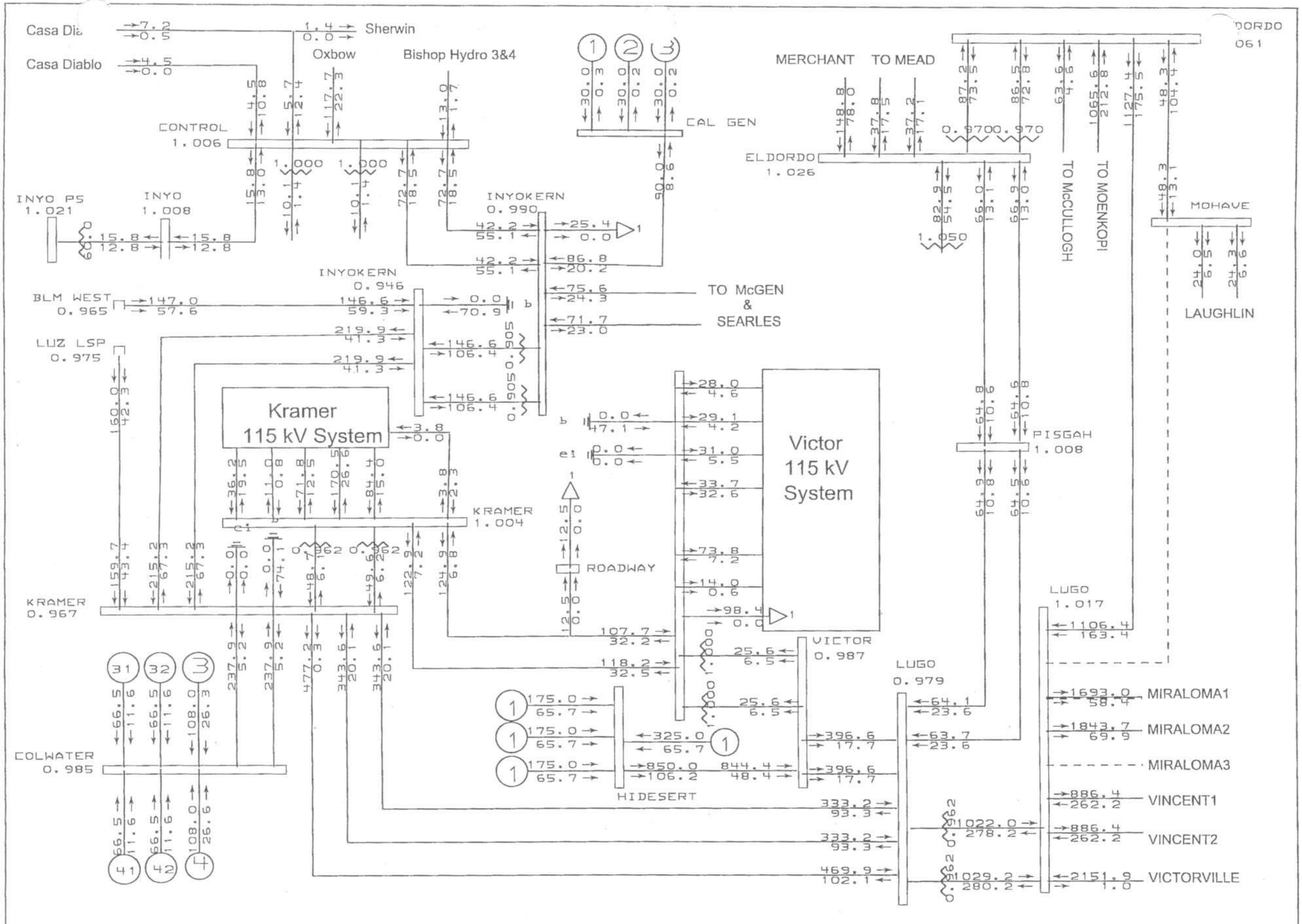
Wed Jan 25 15:35:38 2006

	Solar I System Impact Study: Post-Project 2009 Spring Load Conditions Power Flow Case with SES Plant at 850 MW	N-2: Lugo-Mira Loma No. 2 500 kV Line and Eldorado-Lugo 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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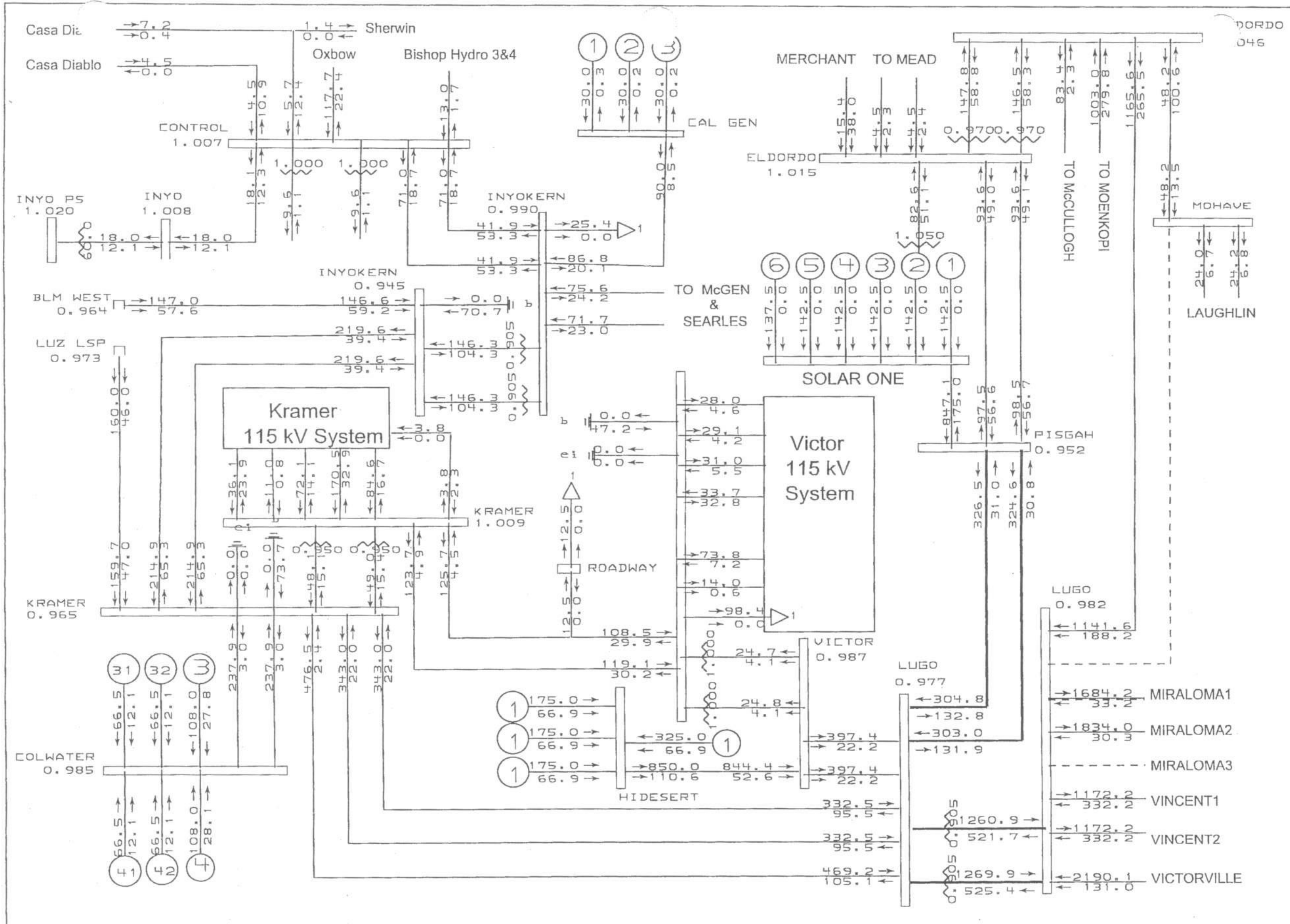
Wed Jan 25 15:33:44 2006

	Solar I System Impact Study: Pre-Project 2009 Spring Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-2: Lugo-Mira Loma No. 3 500 kV Line and Lugo-Mohave 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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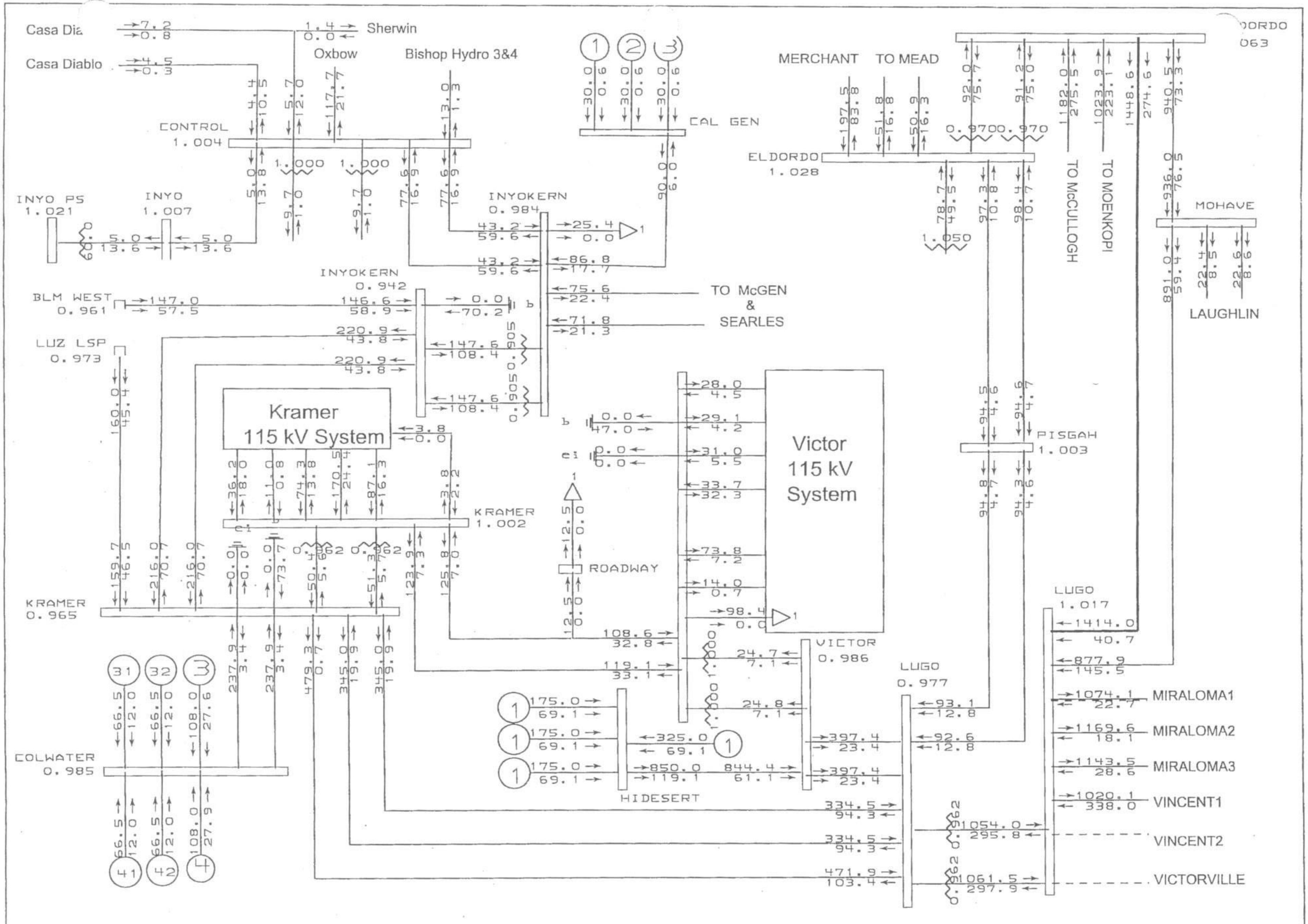
Wed Jan 25 15:35:44 2006

Solar I System Impact Study: Post-Project 2009 Spring Load Conditions Power Flow Case with SES Plant at 850 MW	N-2: Lugo-Mira Loma No. 3 500 kV Line and Lugo-Mohave 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2



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Wed Jan 25 15:33:48 2006

Solar I System Impact Study: Pre-Project 2009 Spring Load Conditions Power Flow Case with Significant Pre-Proj Upgrades	N-2: Lugo-Victorville 500 kV Line and Lugo-Vincent No. 2 500 kV Line	PSLF Program C:\upslf143\MyP Rating =2